

**EPA Superfund  
Record of Decision:**

**F.E. WARREN AIR FORCE BASE  
EPA ID: WY5571924179  
OU 08  
CHEYENNE, WY  
09/28/2001**

**UNITED STATES AIR FORCE**

**INSTALLATION RESTORATION  
PROGRAM**

**FINAL**

**Record of Decision  
for Zone B: Operable Unit 8, Landfill 5**



**F.E. WARREN AFB  
CHEYENNE, WYOMING**

**05 July 2001**

## TABLE OF CONTENTS

### I. DECLARATION

A. SITE NAME AND LOCATION	1
B. STATEMENT OF BASIS AND PURPOSE	1
C. ASSESSMENT OF THE SITE	1
D. DESCRIPTION OF THE SELECTED REMEDY	1
E. STATUTORY DETERMINATIONS	2
F. DATA CERTIFICATION CHECKLIST	2
G. AUTHORIZING SIGNATURES	4

### II. DECISION SUMMARY

A. SITE NAME, LOCATION, AND DESCRIPTION	7
B. SITE HISTORY AND ENFORCEMENT ACTIVITIES	7
C. HIGHLIGHTS OF COMMUNITY PARTICIPATION	9
D. SCOPE AND ROLE OF OPERABLE UNIT	9
E. SITE CHARACTERISTICS	11
F. CURRENT AND POTENTIAL FUTURE LAND AND WATER USES	15
G. SUMMARY OF SITE RISKS	16
H. REMEDIAL ACTION OBJECTIVES	22
I. DESCRIPTION OF ALTERNATIVES	22
J. COMPARATIVE ANALYSIS OF ALTERNATIVES	27
K. PRINCIPAL THREAT WASTES	30
L. SELECTED REMEDY	31
M. STATUTORY DETERMINATIONS	38
N. DOCUMENTATION OF SIGNIFICANT CHANGES FROM PREFERRED ALTERNATIVE OF PROPOSED PLAN	41

### III. RESPONSIVENESS SUMMARY

A. STAKEHOLDER ISSUES AND LEAD AGENCY RESPONSES	42
B. TECHNICAL AND LEGAL ISSUES	42

### List of Tables

Table A1-1	Selection of Human Health COPCs for Surface Water
Table A2-1	Cancer Classification for Human Health Risk Assessment
Table A2-2	Toxicity Values for Human Health Risk Assessment
Table A3-1	Summary of Health Risks, Child/Adult Recreational Visitors
Table A3-2	Summary of Health Risks, Youth Resident
Table A3-3	Summary of Total Hazard Indices and Cancer Risks
Table A4-1	Summary of Ecological Chemicals of Potential Concern
Table A4-2	Ecological Exposure Pathways of Concern
Table A5-1	Summary of Detailed Analysis of Remedial Alternatives
Table A6-1	Proposed Performance Monitoring Analytical List
Table A6-2	WCA Detection Monitoring Constituents
Table A7-1	Detailed Cost Summary Tables for Groundwater Remedy
Table A7-2	Detailed Cost Summary Tables for WCA Remedy
Table A8-1	Chemical-Specific ARARs for Groundwater
Table A8-2	Action-Specific ARARs for Groundwater
Table A8-3	Location-Specific ARARs (and TBCs) for Groundwater
Table A8-4	Chemical-Specific ARARs for WCA
Table A8-5	Action-Specific ARARs for WCA
Table A8-6	Location-Specific ARARs (and TBCs) for WCA
Table A9-1	Cost Effectiveness Matrix

## List of Figures

Figure 1	Site Location Map for Zone B
Figure 2	Zone B Area Map
Figure 3	Human Health Conceptual Site Model
Figure 4	Ecological Conceptual Site Model
Figure 5	Aerial Extent of TCE Plume in Zone B
Figure 6	Vertical Extent of LF5b TCE Plume (Cross-Section A-A')
Figure 7	Vertical Extent of LF5b TCE Plume (Cross-Section B-B')

## List of Attachments

Attachment A1	Selection of Human Health COPCs for Surface Water
Attachment A2	Cancer Classification and Toxicity Values
Attachment A3	Summary of Health Risks
Attachment A4	Summary of Ecological Chemicals of Potential Concern and Ecological Exposure Pathways of Concern
Attachment A5	Summary of Detailed Analysis of Remedial Alternatives
Attachment A6	Proposed Performance Monitoring Analytical List and WCA Detection Monitoring Constituents
Attachment A7	Detailed Cost Summary Tables for Selected Remedy
Attachment A8	Chemical, Action, and Location Specific ARARs
Attachment A9	Cost Effectiveness Matrix
Attachment A10	Response to EPA and WDEQ Comments

## LIST OF ACRONYMS

ug/L	micrograms per liter
AFI	Air Force Instruction
ARARs	applicable or relevant and appropriate regulations
BGP	Base General Plan
bgs	below ground surface
BRA	baseline risk assessment
CCOP	Composite Constraints and Opportunities Plan
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COCs	Chemicals of Concern
COPCs	Chemicals of Potential Concern
CRP	community relations plan
CSM	conceptual site model
CT	central tendency
CWA	Clean Water Act
DCE	cis-1,2-dichloroethene
DERA	Defense Environmental Restoration Account
DERP	Defense Environmental Restoration Program
DOD	Department of Defense
DRMO	Defense Reutilization Marketing Office
DRU	Direct Reporting Unit
EBS	Environmental Baseline Survey
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U. S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ERLUCP	Environmental Restoration Land Use Control Plan
ESD	Explanation of Significant Differences
FEW	F. E. Warren Air Force Base
FFA	Federal Facility Agreement
FOA	Field Operating Agency
FPTA	Fire Protection Training Area
FS	Feasibility Study
GAC	granular activated carbon

## LIST OF ACRONYMS (Continued)

gpm	gallons per minute
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	Hazard Quotient
ICBM	intercontinental ballistic missile
IRA	Interim Remedial Action
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
LF	Landfill
LTM	Long-Term Monitoring
MAJCOM	Major Command
MCLs	maximum contaminant levels
mg/kg	milligrams per kilogram
msl	mean sea level
NCEA	National Center for Environmental Assessment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operation and maintenance
OBODA	Open Burning/Open Detonation Area
OU	Operable Unit
PCBs	polychlorinated biphenyls
PPE	personal protective equipment
PRB	Permeable Reactive Barrier
RAB	Restoration Advisory Board
RACER	Remedial Action Cost Engineering and Requirements
RAOs	Remedial Action Objectives
RA	remedial actions
RBCs	risk based concentrations
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
SVOCs	semivolatile organic compounds
TBCs	to be considered
TCE	trichloroethene
USAF	United States Air Force
USC	U. S. Code
USFWS	U. S. Fish and Wildlife Service
VOCs	volatile organic compounds
WCA	Waste Co-location Area
WDEQ	Wyoming Department of Environmental Quality
WSA	Weapon Storage Area

**I. DECLARATION  
FOR THE RECORD OF DECISION  
REMEDIAL ACTION AT ZONE B: OPERABLE UNIT 8, LANDFILL 5  
F. E. WARREN AIR FORCE BASE**

**A. SITE NAME AND LOCATION**

The site name is F. E. Warren Air Force Base (FEW), and it is located in Cheyenne, Wyoming. This site was placed on the National Priorities List (NPL) in February 1990 and was assigned the National Superfund Database identification number WY5571924179. This Record of Decision (ROD) addresses remedial actions (RAs) at Zone B: Operable Unit (OU) 8, Landfill (LF) 5. It primarily addresses the groundwater plume downgradient from LF5b, but also incorporates prior response actions in Zone B that involved both LF5a and LF5b.

**B. STATEMENT OF BASIS AND PURPOSE**

This decision document presents the Selected Remedy for the groundwater beneath Zone B at FEW. This remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for this site.

The U. S. Environmental Protection Agency (EPA) and state of Wyoming Department of Environmental Quality (WDEQ), as oversight agencies, concur with the Selected Remedy. The United States Air Force (USAF) is the lead agency for the site.

**C. ASSESSMENT OF THE SITE**

The response action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of pollutants or contaminants from this site which may present an imminent and substantial endangerment to public health or welfare.

**D. DESCRIPTION OF THE SELECTED REMEDY**

The Selected Remedy for Zone B includes a groundwater extraction and treatment system to remove and treat groundwater contaminated with trichloroethene (TCE) originating from LF5b. The groundwater remediation system will address TCE contamination in groundwater at and downgradient of Zone B, using an estimated four groundwater extraction wells and a granular activated carbon (GAC) treatment unit. In addition to addressing groundwater contamination downgradient of LF5b, the Selected Remedy includes previous response actions at LF5a. The first action was an interim action at LF5a, in which a landfill cover was constructed over the LF5a wastes as a presumptive remedy. The second action was a removal, in which nonhazardous wastes from other landfills on base, including LF5b, were excavated and co-located on the site of LF5a. The LF5a area was re-designated as the Waste Co-location Area (WCA) with this removal. The WCA was designed to meet requirements for a final remedy. Excavation of the wastes is expected to result in clean closure of LF5b.

While the Selected Remedy addresses the principal threat at the site (i.e., a contaminant of concern in groundwater), the final remedy will also address remediation or containment of other contaminants that could pose an unacceptable risk at the site, through the incorporation of the WCA Resource Conservation and Recovery Act (RCRA) Subtitle D cover design.

The major components of the Selected Remedy are summarized as follows:

- A groundwater extraction and treatment system to treat groundwater contaminated with TCE originating from LF5b, consisting of:
  - an estimated four (4) groundwater extraction wells
  - an estimated two (2) 1,000-pound GAC treatment vessels
  - discharge of treated effluent to the Unnamed Tributary of Crow Creek
- A network of groundwater monitoring wells to measure performance of this system.
- Construction of the WCA, which will have a RCRA Subtitle D cover that prevents direct human or ecological contact with non-hazardous wastes and minimizes infiltration of water through the deposited wastes (including wastes removed from LF5b).
- Post-closure monitoring and maintenance for the previously covered LF5a and the WCA.
- Institutional controls to prevent exposure to contaminants and assure effectiveness of the remedy, including:
  - Placement of restrictive notices in the Base General Plan (BGP), and in particular the Composite Constraints and Opportunities Plan (CCOP; a component of the BGP), to prevent groundwater use in the Zone B area, protect the landfill cover, prevent unauthorized access to the WCA, and prohibit unauthorized altering of the pumping, treatment, discharge, and monitoring equipment
  - Review and approval of construction work requests and digging permits in Zone B.
  - Annual review of the BGP (and CCOP) and modification as needed to assure the appropriate controls are maintained.

## **E. STATUTORY DETERMINATIONS**

The Selected Remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to this remedial action, is cost effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. This determination was made by the USAF and has been concurred with by EPA and WDEQ.

This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i. e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment).

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

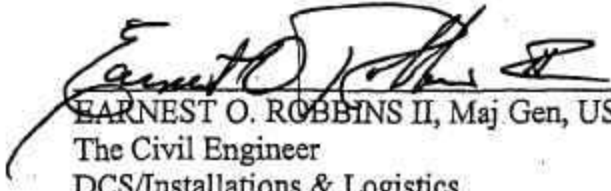
## **F. DATA CERTIFICATION CHECKLIST**

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for this site.

- Chemicals of concern and their respective concentrations.
- Baseline risk represented by the chemicals of concern.
- Cleanup levels established for chemicals of concern and the basis for these levels.
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD.
- Potential land and groundwater use that will be available at the site as a result of the Selected Remedy.
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- Key factor(s) that led to selecting the remedy (i.e., describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision).

## G. AUTHORIZING SIGNATURES

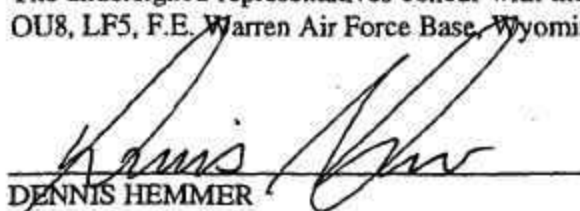
The undersigned representatives concur with the Record of Decision for the Selected Remedy at Zone B: Operable Unit 8, Landfill 5, F. E. Warren Air Force Base, Wyoming.

  
EARNEST O. ROBBINS II, Maj Gen, USAF  
The Civil Engineer  
DCS/Installations & Logistics

13 Sept 01  
DATE

**G. AUTHORIZING SIGNATURES**

The undersigned representatives concur with the Record of Decision for the Selected Remedy at Zone B:  
OU8, LF5, F.E. Warren Air Force Base, Wyoming.

  
DENNIS HEMMER  
DIRECTOR, WYOMING DEPARTMENT  
OF ENVIRONMENTAL QUALITY

9-21-01  
DATE

**G. AUTHORIZING SIGNATURES**

The undersigned representatives concur with the Record of Decision for the Selected Remedy at Zone B: OU8, LF5, F.E. Warren Air Force Base, Wyoming.



MAX H. DODSON

ASSISTANT REGIONAL ADMINISTRATOR

ECOSYSTEMS PROTECTION AND REMEDIATION

U.S. ENVIRONMENTAL PROTECTION AGENCY - REGION 8

9/28/01  
DATE

**II. DECISION SUMMARY**  
**FOR THE RECORD OF DECISION**  
**REMEDIAL ACTION AT ZONE B: OPERABLE UNIT 8, LANDFILL 5**  
**F. E. WARREN AIR FORCE BASE**

**A. SITE NAME, LOCATION, AND DESCRIPTION**

F. E. Warren Air Force Base (FEW) occupies 5,866 acres immediately adjacent to and hydrogeologically upgradient of the west side of the city of Cheyenne, Wyoming (Figure 1). FEW was placed on the National Priorities List (NPL) on February 21, 1990 and was assigned the National Superfund Database Identification Number WY5571924179. Zone B is located along the southwestern boundary of the base, north of Military Road and the Fair Acres subdivision, south of the Weapon Storage Area (WSA), and bisected by Cheyenne Road (Figures 1 and 2).

Zone B encompasses an area identified as Operable Unit 8 (OU8). OU8 is one of 13 OUs that will be investigated. OUS contains Landfill (LF) 5, which is subdivided into two subunits—LF5a and LF5b, and the contaminated groundwater associated with LF5b. A third subunit within OUS, referred to as LF5c, was determined during the Zone B Remedial Investigation (RI) not to be a landfill. Zone B also contains the helicopter landing area. Diamond Creek is located to the north of LF5, and an Unnamed Tributary to Crow Creek is present and extends beyond Zone B, just north of LF5b (Figure 2).

The LF5 subunits include an area of approximately 21 acres. Landfills 5a and 5b comprise an area of approximately 15 acres and 6 acres, respectively (USAF 1995). The LF5 area occupies a topographic high relative to the rest of the base at an elevation of 6,200 feet above mean sea level (msl). Zone B is characterized by rolling hills that gradually slope towards the Unnamed Tributary to the southeast. The topography at LF5b gradually slopes to the east and north towards the Unnamed Tributary (Figure 2).

The United States Air Force (USAF) is the lead agency for implementing Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requirements at FEW. The USAF provides documents to the U. S. Environmental Protection Agency (EPA) and Wyoming Department of Environmental Quality (WDEQ) for review and concurrence. The Defense Environmental Restoration Program (DERP) provides for cleanup of Department of Defense (DOD) hazardous waste sites at operating installations and formerly used defense sites. The Air Force's cleanup program under the DERP is the Installation Restoration Program (IRP). The overall program goal of the IRP is to clean up previously contaminated areas to an acceptable level of risk. Site activities conducted under the IRP are supported by funds from the Defense Environmental Restoration Account (DERA).

**B. SITE HISTORY AND ENFORCEMENT ACTIVITIES**

Historically, FEW has served a number of military functions, including cavalry outpost, quartermaster depot, and intercontinental ballistic missile (ICBM) operations base. Operations began at the U. S. Army outpost named Fort D. A. Russell in 1867. The name was changed to Fort F. E. Warren in 1930. The Fort was a major training facility during and after World War n. Fort F. E. Warren was transferred to the newly formed USAF in 1947. FEW underwent extensive renovation after World War n. The majority of the Army training facilities were torn down and not replaced. Construction since that time has centered on facilities for the USAF operations. Beginning in 1958, FEW became a Strategic Air Command base. Since then, FEW has served as an operations center for (1) the Atlas ICBM, (2) the Minuteman I and III, and (3) the Peacekeeper (MX) ICBMs. FEW was part of Air Combat Command from 1992 to 1993, and in July 1993, became part of Space Command.

Based on historical records and previous site investigations, LF5a and LF5b operated from approximately 1956 to 1970 and consisted of several burn pits and a series of trenches. Refuse from FEW shops and housing areas was transported to the landfill area on a daily

basis and deposited in burn pits, where waste was burned for volume reduction. Burn pit residue was removed from the pits and placed in disposal trenches, which were then covered with soil. Trenches were estimated to be 15 to 20 feet deep and up to 600 feet long (USAF 1995). The refuse disposed in LF5a and LF5b was reported to be domestic waste and shop wastes including solvents, waste oils, ethylene glycol, silicone oil, hydraulic fluid, waste JP-4 jet fuel, batteries, expired pesticides, paints, asbestos insulation, and incinerator ash. The volume of fill was estimated at 600,000 cubic yards, but it is not known whether this volume includes LF5b. During a field reconnaissance in 1992, ash, cinders, and construction debris were observed on the surfaces of the landfills.

Based on an installation-wide records search performed during 1985 (Engineering Science 1985), LF5 was identified as a potential source of contaminants to the environment. On February 21, 1990, the EPA placed FEW on the NPL, which brought it under the federal facilities provisions of Section 120 of CERCLA. On September 26, 1991, the USAF, EPA (Region VIII), and the state of Wyoming signed a Federal Facility Agreement (FFA) to perform installation-wide environmental investigations and restoration. The FFA is required by Section 120 of CERCLA. The FFA provides the framework for EPA and WDEQ oversight of continuing remedial investigations at FEW and further identifies the USAF investigation activities and schedules.

A Record of Decision (ROD) for an Interim Remedial Action (IRA) for LF5a was signed in November 1996. Due to potential releases of hazardous materials from LF5a, a composite cap with an active gas-venting system was selected as the IRA. The cap was installed at LF5a in 1998 and designed to minimize moisture infiltration using a low permeability, compacted cover overlain by a stable topsoil layer supporting native vegetation. The IRA identified in the ROD was modified through an Explanation of Significant Differences (ESD) in November 1998. The ESD provided for elimination of the gas venting system, because it was determined that the gases generated by the landfill were minimal and did not require an active venting system under applicable or relevant and appropriate regulations (ARARs). Post-closure monitoring and maintenance for the cover began in April 1999.

A removal action for LF5b was scheduled for initiation and was completed in the year 2000. Waste removed from LF5b was relocated to the Waste Co- location Area (WCA), formerly designated as LF5a. Because wastes were excavated, LF5b is expected to achieve "clean closure," which will result in no limitations on exposure or access to the LF5b surface area. The clean closure is therefore incorporated into the Selected Remedy for Zone B.

A records search and review of available documents did not confirm the existence of LF5c. Aerial photo reviews, geophysical surveys, and exploratory trenching were performed to assess suspected waste material at LF5c. The aerial photos and historical records identified old officers' quarters in this area from 1941 to 1960, after which time they were demolished. Trenching identified building demolition materials (bricks, concrete slabs, etc.) in the near surface (0-2.5 feet below ground surface [bgs]) which are believed to be associated with the demolition of these buildings. No landfill material was encountered during the trenching conducted at LF5c and clean soils were present below the debris. Also, there were no written records regarding LF5c operations (USAF 1995).

Zone B has had no cited violations under federal or state environmental regulations or statutes, including CERCLA. There are no past or pending lawsuits relating to site cleanup.

## **C. HIGHLIGHTS OF COMMUNITY PARTICIPATION**

The USAF has prepared and implemented a community relations plan (CRP) in accordance with CERCLA requirements and the FFA. The CRP describes community involvement activities that the USAF will undertake during remedial activities at FEW. The USAF has followed the requirements of the CRP, including issuing periodic fact sheets, holding public meetings, and providing the opportunity for public comment throughout the cleanup process.

The Administrative Record has been filed at two locations: the FEW Environmental Restoration Management Office and the Laramie County Public Library. The Final Zone B RI report was issued August 2000 and the Final Zone B Feasibility Study (FS) report was issued December 2000. The USAF prepared and distributed one fact sheet describing the preferred alternative for Zone B to all persons or groups identified on the CRP mailing list. The fact sheet was mailed on 13 December 2000. Currently, the mailing list has approximately 1,300 listings.

The announcement of commencement of the public comment period and public meeting for this ROD was made on 13 December 2000 through press releases and notices in the Wyoming *Tribune-Eagle*. The public comment period was 20 December 2000 to 19 January 2001 and a public meeting to discuss this ROD was held in Cheyenne, Wyoming on 9 January 2001. One member of the public attended the meeting and no comments on the Zone B Proposed Plan were received. Proposed Plan Official transcripts of the public meetings were prepared and placed in the Administrative Record.

On a monthly basis, Restoration Advisory Board (RAB) meetings were held in Cheyenne. The RAB updates attending community members on the status of investigative activities and the decision-making process, solicits input from members, and provides training and tours to the members. The RAB members were briefed periodically on Zone B: OU8, LF5 and were specifically consulted on the preferred alternative in the 14 November 2000 RAB meeting. RAB members asked questions, but offered no comments specifically supporting or opposing the preferred alternative.

#### **D. SCOPE AND ROLE OF OPERABLE UNIT**

OU8 is one of 13 OUs that are being addressed under the terms of the FFA. The OUs are at various stages in the investigation and cleanup process. Early response actions, including interim remedial actions and removal actions have been conducted at OU2, OU3, OUS, OU9 and OU11 to date. These response actions will be consistent with the final actions selected. This is the fourth ROD for a final remedy at FEW. The OUs identified at FEW are:

- OU1 Spill Sites 1 through 7 Soils
- OU2 Spill Sites 1 through 7 Groundwater, Fire Protection Training Area (FPTA) 2 Groundwater, Plumes A through E Groundwater
- OU3 Landfill 6 (All Media)
- OU4 Acid Dry Wells (All Media)
- OU5 FPTA 2 Soils
- OU6 Open Burning/ Open Detonation Area (OBODA) (All Media)
- OU7 Firing Ranges (All Media)
- OU8 Landfill 5 (All Media) - (The subject of this ROD)
- OU9 Landfill 2 (All Media except groundwater which is addressed as part of OU2)
- OU10 FPTA 1 and Landfill 7 (All Media except groundwater which is addressed as part of OU2)
- OU11 Landfill 3 (All Media)
- OU12 Landfill 4 (All Media)
- OU13 Plumes A through E (Sources)

For management purposes, FEW was divided into five zones: A through E. The delineation of the zones is based on geographic features (e.g., surface water drainages) and distinguishing features (e.g., prominent features such as LF5). A zone may consist of one or several OUs. In the case of Zone B, it includes only OUS.

There have been three previously completed RODs for final remedies at FEW. The OU4 ROD was signed on 30 December 1992 and addressed the contamination associated with an acid dry well at the old transportation complex. Based on previously completed contaminated soil removal, the baseline risk assessment indicated no significant risk to human health and the environment. Therefore, no further action was required at this site.

OUS addressed the Fire Protection Training Area #2 (FPTA2) soils. The ROD for this OU was signed on 4 November 1994 and also indicated no further action required based on the risk assessment findings of no significant risk to human health and the environment. As part of this decision, the groundwater beneath FPTA2 was made part of OU2 basewide groundwater.

The OU1 ROD was signed on 9 August 1995 and addressed the contaminated soils at spill sites 1 through 7. The risk assessment conducted for this OU indicated that there was no significant risk to human health and the environment; therefore, the ROD indicated that no further action was required for the soils at these sites. However, the groundwater beneath these sites was not included and it was also made part of OU2, which is presently in the investigation phase of the cleanup process.

The remaining OUs will be investigated and RODs completed in the following general order: OU8-2001, OU11-2001, OU3-2001, OU6-2002, OU9-2003, OU12-2003, OU10-2004, OU13-2004, OU2-2005, and OU7-2009. Presently, the OU8 design investigation activities are scheduled to begin in Fall 2001, and design activities are scheduled for completion in Spring 2002 with implementation of the remedy in late 2002 and early 2003.

Cleaning up contaminated groundwater represents the last remaining action for Zone B. A 1996 Interim ROD provided for a landfill cover that was placed over LF5a in 1998 to minimize infiltration throughout the landfill and prevent direct exposure to waste. LF5b was excavated in its entirety during 2000 to remove any contaminant sources and the waste moved to the WCA per the 2000 Action Memorandum (USAF 2000c). The Remedial Action Objectives (RAOs) are to restore groundwater to beneficial use and incorporate the WCA and LF5b removal into the final remedy. Together, these actions comprise the final action for Zone B that will meet the RAOs and will permanently reduce the toxicity, mobility, and volume of the contamination within Zone B.

## **E. SITE CHARACTERISTICS**

### ***Conceptual Site Model***

The conceptual site model (CSM) for Zone B identified LF5b waste as the primary source of TCE in groundwater. This landfill waste was situated within geologic materials primarily consisting of interbedded clays, silts, sandy silts, and silty sands. The principal contaminant release mechanism is assumed to have been leaching of buried waste within LF5b and subsequent infiltration to groundwater. Groundwater in the area of LF5b is approximately 10 to 15 feet below the ground surface and aquifer materials consist of interbedded clays, silts, sandy silts, and silty sands. LF5b is no longer a source of current or future contamination to the surrounding environment due to the excavation and removal of the landfill in 2000 and expected clean closure.

Migration of contaminated groundwater from LF5b is controlled by local hydraulic gradients that trend in a northeasterly direction toward Unnamed Tributary. Typical horizontal gradients are approximately 0.01 feet/foot. Using this data and an average hydraulic conductivity value of 7.4 feet/day, a typical groundwater velocity of 0.37 feet/day (135 feet/year) was calculated. As contaminated water migrates downgradient of LF5b, empirical data and model simulations indicate that contaminant concentrations attenuate due to natural processes of volatilization, dilution, and adsorption.

Figures 3 and 4 depict the human health and ecological CSMs for Zone B. These models illustrate the primary contamination source (landfill waste), release mechanisms, exposure pathways, migration routes, and potential human and ecological receptors. These CSMs form the basis for the risk assessment conducted for the site (see Section G below).

### ***Site Overview***

Zone B is defined as that portion of FEW north of Military Road/Fair Acres subdivision along the southwestern boundary of the base, south of the WSA, and bisected by Cheyenne

Road (Figure 2). Zone B contains a total of 275 acres, including the LF5 subunits, adjacent areas, and the helicopter landing area. Diamond Creek is located to the north of LF5, and an Unnamed Tributary to Crow Creek is present within the confines of LF5, just north of LF5b.

The LF5 subunits include an area of approximately 21 acres. Landfills 5a and 5b comprise an area of approximately 15 acres and 6 acres, respectively (USAF 1995). The LF5 area occupies a topographic high relative to the rest of the base at an elevation of 6,200 feet above msl. Topographic contours for Zone B are shown on Figure 2. Zone B is characterized by rolling hills that gradually slope towards the Unnamed Tributary to the southeast. The topography at LF5b gradually slopes to the east and north towards the Unnamed Tributary.

In general, groundwater surface elevations mimic surface topography, with an east-northeasterly flow direction from topographically higher areas toward Crow Creek. Regional groundwater flow follows the regional surface water flow direction (USGS 1967; Crist 1985). Recharge to the aquifer occurs by infiltration of local precipitation and upgradient sources.

Groundwater flow directions in the Zone B area are generally from southwest to northeast. The hydraulic gradient in this area ranges from 0.008 to 0.03 feet/foot, as shown in the potentiometric surface measured during Phase 1 of the RI (September 1999). The typical horizontal hydraulic gradient is approximately 0.01 feet/foot. This is consistent on a seasonal basis, and there is no evidence for reversals in the groundwater gradient. Site data suggest that the aquifer is recharging in higher elevations and reaches of the Unnamed Tributary, and discharging eastward toward the lower reaches of Unnamed Tributary. This hypothesis is further supported by the "gaining" nature of the Unnamed Tributary as it travels downstream east-northeast.

Water levels in wells fluctuate seasonally an average of several feet, and can rise and fall as much as 5 feet following periods of high precipitation and dry periods. The greatest fluctuation in groundwater elevation at any of the Zone B wells during the period of record (up to 8 years) is approximately 8.1 feet (Well MW-265).

Horizontal hydraulic conductivity was determined by aquifer tests conducted during the Focused RI (USAF 1995) and Zone B RI (USAF 2000a). The measured hydraulic conductivity ranges from 0.007 to 198 feet/day. A geometric mean of 7.4 feet/day was calculated in the Zone B RI (USAF 2000a). Using the geometric mean of horizontal hydraulic conductivity, the typical value for the hydraulic gradient (0.01 feet/foot), and an assumed effective porosity of 20 percent (USAF 1991), a horizontal groundwater velocity was calculated to be approximately 0.37 feet/day (135 feet/year). However, due to the highly variable nature of site geologic conditions, site groundwater velocities are expected to vary considerably.

Crow Creek and two of its tributaries, an Unnamed Tributary and Diamond Creek, drain most of the southern part of FEW. Diamond Creek is perennial along most of its length. It appears to be hydraulically connected to the shallow groundwater system as a discharge location as it is primarily a gaining stream. Crow Creek and Diamond Creek are present to the north of Zone B and the Unnamed Tributary meets Crow Creek approximately one mile downstream of Zone B. Within Zone B, the Unnamed Tributary of Crow Creek has alternating reaches that are perennial, intermittent, and ephemeral (USAF 1995). The Unnamed Tributary is shallow, has a minimal flow, and is overgrown with grasses and bushes in the vicinity of LF5b. No floodplains exist along the Unnamed Tributary.

Surface water in Zone B is present in the form of stream flow and groundwater seeps. The sources of stream flow include runoff from precipitation and discharge from groundwater. Groundwater seeps occur where the groundwater surface intersects the ground surface. These seeps are evident along the Unnamed Tributary and are identified by growths of aquatic vegetation (e. g., cattails) or seasonal pooling of water.

The banks of the Unnamed Tributary support riparian vegetation, including some wetland areas. The habitat ranges of several federally-listed threatened, endangered, or candidate

species are known to be present at FEW. Several listed species are potentially present in these riparian areas (Prebles Meadow Jumping Mouse and Colorado Butterfly Plant). Areas of historical or archaeological importance have not yet been surveyed in this area, but will be identified prior to construction.

### ***Site Sampling***

Field investigations were conducted in three phases during 1999 and 2000 as part of the RI for Zone B. The investigations were conducted because previous investigations had identified four areas of contamination in the shallow groundwater in Zone B, near the westernmost part of LF5a and north, northeast, and southeast of LF5b. The sampling strategy was developed to meet the following data quality objectives developed in conjunction with EPA and WDEQ:

- Delineate dimensions of LF5b and LF5c
- Evaluate nature and extent of contamination of landfill materials, surface contamination lateral to and downwind of landfills, and subsurface contamination lateral to landfills
- Assess the nature and extent of groundwater contamination in Zone B
- Develop a conceptual hydrogeologic model to evaluate if off-base TCE contamination is related to LF5
- Estimate the potential for risk to human health and the environment
- Collect data to support potential FS alternatives

In brief, the field program included the installation of new groundwater monitoring wells, waste characterizations, collection of geologic and hydrogeologic data, and collection and analyses of groundwater, surface water, sediment, and surface and subsurface soil samples.

All samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), organochloride pesticides, polychlorinated biphenyls (PCBs), and metals (except surface soils, where VOCs were not included), along with other standard groundwater parameters.

### ***Sampling Results: Nature and Extent of Contamination***

Surface and subsurface soil contaminants included SVOCs, organochlorine pesticides, and metals. These contaminants are distributed in the vicinity and downwind (southeast) of LF5a and LF5b. SVOCs were detected in subsurface soils at a maximum concentration of 4.7 milligrams per kilogram (mg/kg). Organochlorine pesticides were detected at concentrations of 7.41 mg/kg or less in surface soils. Metals were also detected in surface and subsurface soils at low concentrations. The pesticide detections are likely a result of pesticide applications associated with FEW pest management activities. A specific source of metals and SVOCs is not apparent.

In groundwater, TCE, bis(2-ethylhexyl) phthalate (a common laboratory and field contaminant), and nitrates were observed at concentrations above federal maximum contaminant levels (MCLs). TCE is the most widespread groundwater contaminant and occurs at the highest concentrations among the detected VOCs; it was detected at a maximum concentration of 76 micrograms per liter (ug/ L). TCE was detected above MCLs at seven wells in Zone B during Phase 1, Phase 2, and Phase 3. Bis(2-ethylhexyl) phthalate detections were not consistent between sample events and a distribution pattern of detections is not apparent. Therefore, bis(2-ethylhexyl) phthalate is not site related, but is considered to be a laboratory or field contaminant. Nitrates appear to be originating off base to the southwest of the base.

As discussed in the RI Report (USAF 2000a), a second TCE plume was identified about 200 feet north of the LF5b TCE plume. This plume is assumed to have a separate, off-site source as evidenced by the TCE concentrations located hydraulically upgradient of LF5b and at the edge of the base property (e. g., wells MW-020 and LF5-102). The highest reported TCE concentration in this plume was 10.4 ug/L detected in well LF5-103D. The plume extends for a length of approximately 1,400 feet and has an average width of 150 feet.

Based on contaminant distribution and direction of groundwater flow, the contaminant source is understood to be hydraulically upgradient of LF5b and located off base. Because of the off-base origin of the contaminant source, this plume is not being addressed for cleanup in this Zone B FS.

Surface water contaminants include VOCs and metals. As in soils, contaminant concentrations were low. The distribution of contaminants is not indicative of specific sources within Zone B, except for TCE, which is likely emanating from LF5b and/or the off-base source.

Sediment contaminants include VOCs, SVOCs, pesticides, and metals. The source of TCE, and cis-1,2-dichloroethene (DCE) is likely attributed to Zone B or the off-base source. The detection of bis(2-ethylhexyl) phthalate is not attributed to Zone B, but, as in groundwater, is considered to be a laboratory or field contaminant. Metals were not detected at concentrations exceeding FEW background levels in sediment.

Contaminated groundwater is relatively shallow, with a maximum estimated depth of approximately 50 feet bgs. Figures 5, 6, and 7 depict the lateral and vertical extent of the TCE plume. The lateral dimensions of the TCE plume with concentrations exceeding the MCL are approximately 1,000 feet by 300 feet. Figures 5, 6, and 7 depict the lateral and vertical extent of the TCE plume. For purposes of calculating the contaminant mass, an average depth of 40 feet below the potentiometric surface and an average TCE concentration of 15 ug/L were assumed. Using the above data, an effective porosity of 0.2, and krigging methods, the total volume of contaminated water in the LF5b plume was calculated to be  $1.735 \times 10^7$  gallons and the calculated contaminant mass determined to be 2.2 pounds. Additional details regarding the nature and extent of contamination can be found in the Zone B RI report (USAF 2000a).

### ***Groundwater Modeling***

Groundwater flow and transport modeling was conducted to improve the understanding of the site hydrogeologic and groundwater contaminant conditions and to simulate various remedial alternatives. Detailed description of the model's development can be found in Appendix A of the Zone B FS (USAF 2000b).

A steady state groundwater flow model for Zone B was developed using MODFLOW, the USGS finite difference code. This model covers an area of about 3000 feet by 2000 feet, and is orientated with the primary groundwater flow direction. The model is comprised of two layers based on the assumption that no distinguishable hydrostratigraphy is found at the site. The groundwater potentiometric surface was interpreted from the measured hydraulic heads in September 1999 (Figure 5). These data were used as the target for model calibration, assuming that minor seasonal groundwater fluctuation is negligible in assessing contaminant migration. The bottom of model Layer 1 is assumed to be 40 feet below the interpreted potentiometric surface and the bottom of model Layer 2 is assumed to be 40 feet below the bottom of Layer 1. Boundary conditions for all sides of the model domain were assumed to be prescribed head boundary conditions with specified values as same as the interpreted potentiometric surface at the boundaries.

The flow model was calibrated to the interpreted potentiometric surface using the depth-weighted average hydraulic conductivity that ranges from 3 to 30 feet/day. An automated groundwater model calibration package MODAC (Guo and Zhang 2000) was used. The final areal groundwater recharge rate was calibrated as 1.0 inches/year in the area of recharge (majority of area) and -0.5 inches/year along the Unnamed Tributary to reflect

evapotranspiration along the creek. The calibrated potentiometric surface generally matches the interpreted one, which indicates that the simulated hydraulic heads match the measured hydraulic heads.

The three-dimensional groundwater solute transport code MTDMS (Zheng and Wang 1998) in conjunction with MODPATH, a particle tracking code, was used to simulate the TCE plume migration in groundwater. Various conditions were modeled to evaluate the potential effect of remedial alternatives. Assumptions applied in the solute transport model include:

- No source was simulated, reflecting the condition that LF5b has been excavated.
- The interpreted horizontal TCE plume based on September 1999 measurements was assumed to be the initial concentration distribution in the upper 40 feet of the saturated zone (Layer 1).
- Longitudinal and transverse dispersivity values are assumed to be 2.0 feet and 0.2 feet, respectively.
- No biodegradation was simulated.
- The retardation factor was calculated as 3.1 based on assumed parameters for soil density, effective porosity, fraction organic carbon, and Koc.

No calibration was performed for the transport model. The transport model simulates the future plume migration under either natural conditions or active remedial conditions. The initial concentration distribution is assumed to be the same as the 1999 conditions without the presence of the contaminant source. The natural attenuation simulation indicates the TCE plume is mobile, and the TCE concentrations will be continuously decreasing over time within the moving plume. This is consistent with empirical data in that the observed high concentrations in the center of the plume have continuously decreased between 1994 and 2000. Empirical data supporting natural attenuation are presented in the Focused Remedial Investigation for Operable Unit 8: Zone B at F. E. Warren Air Force Base, Wyoming; the Remedial Investigation for Operable Unit I at F. E. Warren Air Force Base, Wyoming; the Zone B Final Treatability Study Report, F. E. Warren Air Force Base, Wyoming; the Zone B Shutdown Monitoring (9/18/96, 10/2/96 and 10/3/96, respectively); and the Zone B - Field Activities Report Surface Water Sampling (4/17/97 and 6/16/97). These reports can be found in the Administrative Record.

The human/ecological populations that could be affected are identified in conceptual site models (Figures 3 and 4). The risk assessment identified no quantifiable risk for either humans or the environment.

## **F. CURRENT AND POTENTIAL FUTURE LAND AND WATER USES**

Currently, Zone B supports industrial and open space uses. The site includes the WCA (LF5a), the helicopter landing area and administrative buildings in the southeast corner, and the remedial action related uses occurring at LF5a, LF5b, and scattered monitoring well and sampling locations. Cheyenne Road bisects the site from north to south, and Artillery Road branches off Cheyenne Road to the east. The remainder of the site is undeveloped open space.

Access to LF5 in Zone B is not permitted without clearance from the WSA. Maintenance, security, pest control, and landscaping personnel may occasionally work in Zone B. Primary human activities in the landfill area are security activities at the WSA.

Current adjacent land uses include the 80-acre Fair Acres residential subdivision, located approximately one-half mile to the south of LF5a; undeveloped open space to the west; the WSA to the north; and open space and base administrative buildings to the east and

southeast.

The FEW Base General Plan (BGP) depicts both present and future use of Zone B as open space and industrial (including airfield pavement). The current land use is presumed to be the reasonably anticipated future land use. Although future residential use is not planned within Zone B, it was considered as a scenario for risk assessment purposes.

Zone B ground and surface waters are currently not used for human consumption or recreation, but support wildlife. Although the regional aquifer has been impacted by the LF5b TCE plume, restrictive notices in the BGP prevent the use of the groundwater as drinking water. Furthermore, drinking water at FEW is supplied by the municipality of Cheyenne. The groundwater within Zone B eventually discharges to downstream surface water tributaries or occasional surface seeps.

Surface water in Zone B is present in the form of stream flow and groundwater seeps. The Unnamed Tributary to Crow Creek that traverses the site is shallow, has a minimal flow, and is overgrown with grasses and bushes. It is not known whether groundwater beneath the landfills discharges into the Unnamed Tributary.

It is highly unlikely that future use of the site's groundwater or surface water will differ from the current use, since the Unnamed Tributary is a Class 4 surface water, and no future demand for drinking water is anticipated. Municipal drinking water supplies are readily available and would be used for any construction by the USAF, so the use of contaminated groundwater is unlikely unless the base closed or otherwise transferred the property to the private sector. Since this scenario is not a foreseeable event, no time frame or location of withdrawal can be identified.

## **G. SUMMARY OF SITE RISKS**

The baseline risk assessment (BRA) estimates what risks Zone B poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for Zone B. The BRA for Zone B was conducted in accordance with the Baseline Risk Assessment Scoping Document (USAF 1999b).

### ***Human Health Risk Assessment***

**Identification of Chemicals of Potential Concern and Chemicals of Concern.** Chemicals of Potential Concern (COPCs) were selected from detected chemicals in each sampled medium: surface soil, subsurface soil, groundwater and surface water and sediment in the Unnamed Tributary. COPCs in media not sampled (e. g. air) were identified from relevant sampled media. Attachment 1 summarizes the selection of COPCs. Chemicals of Concern (COCs) then were selected from the COPCs through a quantitative risk evaluation.

Detected chemicals in surface soil, subsurface soil, and surface water and sediment in Unnamed Tributary that were not essential nutrients and that exceeded background levels and EPA Region HI risk based concentrations (RBCs) (adjusted to a hazard quotient [HQ] of 0.1 for noncarcinogens) were selected as COPCs. The COPCs identified for quantitative evaluation were barium, calcium, manganese, and TCE in Unnamed Tributary surface water. No COPCs were identified in surface soil, subsurface soil, or sediment. All quantitative risk assessment results were below a hazard index of 1 and below EPA's target cancer risk range of 1E-06 to 1E-04, and the State of Wyoming's lifetime excess cancer risk factor of 1E-06. Therefore, no COCs were identified in surface soil, subsurface soil, and surface water and sediment in the Unnamed Tributary.

Detected chemicals in groundwater, including TCE, were not compared the Region in RBCs for tap water because direct contact with groundwater is an incomplete pathway in Zone B. However, VOCs, including TCE, could volatilize from groundwater and infiltrate through

residential basements into indoor air, which is a potentially complete pathway in Zone B. For each detected VOC that could volatilize into air, including TCE, the maximum groundwater concentration (76 ug/L for TCE) was used to model indoor air concentrations that could potentially result from VOCs volatilizing out of groundwater and infiltrating into residential basements. The estimated maximum indoor air concentration for each chemical was then compared to the Region HI RBC for ambient air (adjusted to an HQ of 0.1 for noncarcinogens). All six of the VOCs detected in Zone B groundwater, including TCE, were eliminated as COPCs because their modeled maximum indoor air concentrations did not exceed Region HI RBCs for ambient air. Therefore, there are no COPCs or COCs for groundwater.

**Exposure Assessment.** LF5b is considered the primary source of contaminants in Zone B. Historically, contaminants may have been transported from LF5b through percolation of leachate or liquid waste to vadose zone soil and groundwater, or through windblown transport of contaminated dust to surrounding soil. Currently, waste from LF5b has been removed and relocated to the Waste Co-location Area (formerly LF5a). Because wastes were excavated, LF5b is expected to achieve "clean closure" and is no longer a source of Zone B contaminants. Based on current and future land-use scenarios, receptors identified in Zone B were current/future on-site utility workers, current/future on-site child and adult recreational visitors, and hypothetical future on-site child, adult, and youth residents. Section K. 2.2 of the BRA (USAF 2000a) contains a complete discussion of the Zone B exposure assessment.

Utility workers were assumed to work for short durations in Zone B and considered for exposure to Zone B surface and subsurface soil. However, no COPCs with toxicity values were identified in Zone B surface or subsurface soil. Therefore exposures of utility workers were not evaluated further in the human health risk assessment.

On-site child and adult recreational visitors were considered for ingestion, dermal, and inhalation exposure to Zone B surface soil and dermal and ingestion exposure to surface water and sediments in Unnamed Tributary. Because no COPCs with toxicity values were identified in Zone B surface soil or sediments in Unnamed Tributary, the surface soil ingestion, dermal and inhalation and the sediment ingestion and dermal pathways were incomplete and were not evaluated further in the human health risk assessment. COPCs were identified in Unnamed Tributary surface water. Therefore the ingestion and dermal surface water pathway was considered complete for child and adult recreational visitors. Cancer risk and non-cancer health hazards were quantitatively evaluated for current/future on-site child and adult recreational visitors exposed to surface water in Unnamed Tributary through ingestion and dermal pathways.

Hypothetical future residents were assumed to live in Zone B on 5 acre lots. Hypothetical future adult, child and youth residents were considered for ingestion, dermal, and inhalation exposure to Zone B surface soil, ingestion and dermal exposure to surface water and sediments in Unnamed Tributary, and inhalation exposure to indoor air (Infiltration of VOCs in groundwater to indoor air). Because future groundwater use is believed unlikely, the hypothetical future residential scenario did not include domestic use of groundwater. Surface soil, sediments in Unnamed Tributary and indoor air, the surface soil ingestion, dermal and inhalation, the sediment ingestion and dermal, and the indoor air inhalation pathways were incomplete and not evaluated further in the human health risk assessment, because no COPCs with toxicity values were identified in Zone B. COPCs were identified in Unnamed Tributary surface water. Therefore the ingestion and dermal surface water pathway was considered complete for adult, child and youth future residents. Cancer risk and non-cancer health hazards were quantitatively evaluated for future child, adult, and youth residents exposed to surface water in Unnamed Tributary through ingestion and dermal pathways.

**Toxicity Assessment.** Toxicity values specific to oral and inhalation pathways were obtained from the sources listed below in the following hierarchy:

1. Integrated Risk Information System (IRIS) on- line database (EPA 2000a);
2. Health Effects Assessment Summary Tables (HEAST) (EPA 1997); and
3. Provisional toxicity values obtained from EPA's National Center for Environmental Assessment (NCEA), as published in EPA Region III (EPA 2000b).

For evaluating dermal exposure routes, dermal toxicity values were derived by using oral toxicity values adjusted as recommended in the Dermal Risk Assessment Interim Guidance (EPA 1998). Attachment A-2 summarizes the toxicity data used.

EPA weight of evidence classifications, whereby potential carcinogens are grouped according to the likelihood that chemical is a human carcinogen, depending on the quality and quantity of carcinogenic potency data for a given chemical, were employed. Cancer classes A, B, and C were considered carcinogenic in the human health risk assessment.

Chronic RfDs, used to evaluate long-term exposures (7 years to a lifetime), were used as toxicity values for noncarcinogens for all receptors in the human health risk assessment.

Risk Characterization. Non-cancer hazard and cancer risks were quantified for recreational visitors exposed to Unnamed Tributary surface water and hypothetical future residents exposed to Unnamed Tributary surface water. Hazard/risk was estimated for both central tendency (CT) and reasonable maximum exposure (RME) assumptions to provide a range of risk estimates for risk managers to use. Non-cancer hazard estimates are well below a hazard index (HI) of 1[ NM1], the EPA acceptable level for non-carcinogens. Both CT and RME cancer risk estimates for the receptors evaluated are less than 1E-06, the low end of EPA's target cancer risk range of 1E-06 to 1E-04 for carcinogens and Wyoming's target risk criteria. Attachment A-3 summarizes the health risk results.

Utility workers were not evaluated because no COPCs with toxicity values were identified in surface or subsurface soil. Unnamed Tributary sediment-related pathways were not evaluated because no COPCs with toxicity values were identified in Unnamed Tributary sediments, and surface soil pathways were not evaluated because no COPCs with toxicity values were identified in Zone B surface soil.

Domestic use of groundwater was not considered in the human health risk assessment, because it is unlikely Zone B groundwater will be used for domestic purposes. Infiltration of VOCs, including TCE, from groundwater into indoor air was considered, however no COPCs were identified for this pathway.

The major sources of uncertainties associated with the methodologies and assumptions in the Zone B risk are summarized as follows:

- The samples may not have adequately represented media at the site. Because samples were taken where contamination was suspected instead of randomly, exposure point concentrations and resultant hazard/risk estimates were most likely overestimated.
- The minimum detection limit for a few analytes that were eliminated as COPCs (because they were not detected) exceeded toxicity screening values used to identify COPCs. If these analytes were in fact present at the site, the estimated risks may have been underestimated.
- Utility worker exposure to groundwater was not quantitatively evaluated. The estimated risk to utility workers may have been underestimated, however, exposure and risk are likely low.
- Because concentrations of chemicals in site media may decrease over time as chemicals migrate and/ or degrade, risk estimates for current scenarios may overestimate or underestimate future risks.

- Exposure point concentrations used in the risk assessment were the 95% UCL or maximum value (whichever was smaller). Using these concentrations probably overestimates risk.
- Standard assumptions regarding body weight, exposure duration, life expectancy and population characteristics may not be representative of actual Zone B exposure situations. Most of these exposure parameter values are reasonably high- end estimates. Where there was a high uncertainty regarding exposure parameter values, conservative (health protective) values were used. This most probably resulted in an overestimation of risk.
- Proxy toxicity data were used whenever possible for chemicals that lacked toxicity data to screen for COPCs. If proxy data underestimated a chemical's toxicity, risk may have been underestimated. However, it is more likely that the proxy data overestimated a chemical's toxicity and risk was overestimated.
- Trichloroethene toxicity values used in the risk assessment were unverified provisional values, which probably overestimated risk.
- Sources of uncertainty in toxicity data, (e.g. extrapolation of animal data to humans, use of high dose response to predict low dose response, use of data from short term studies to predict long term effects, and employing toxicity values for one exposure route to another exposure route) may result in overestimation or underestimation of risk.
- Possible synergistic or antagonistic effects of exposure to multiple chemicals may result in underestimation or overestimation of risk.

The large number of assumptions made in the human health risk assessment resulted in uncertainty in the risk characterization results. While this could potentially lead to an underestimation of risk, the use of numerous conservative (i.e., protective of human health) assumptions in this risk assessment probably resulted in net overestimation of risk. Therefore, hazard/ risk for actual receptors at the site is probably less than predicted in the human health risk assessment.

Based on the results of the human health risk assessment, it can be concluded with reasonable certainty that:

- Media in Zone B (soil, groundwater, sediments, surface water, and air) do not pose a threat of non-cancer health effects in humans.
- Surface soil, subsurface soil, groundwater, and Unnamed Tributary sediments and surface water in Zone B do not pose cancer risks in exceedance of  $1E-06$ .

### ***Ecological Risk Assessment***

An Ecological Risk Assessment (ERA) was performed following the Baseline Risk Assessment Scoping Document (USAF 1999) to evaluate whether chemicals from LF5a and LF5b have adversely impacted the soils, sediment, or surface water in Zone B.

**Identification of Chemicals of Concern.** To focus the ERA on those chemicals that may be site-related and may potentially pose an unacceptable risk, measured concentrations of chemicals in soil, sediment, and water were compared to a series of screening threshold values. Screening included comparisons with background concentrations of inorganics and comparisons of inorganics and organics with conservative, risk-based thresholds. Based on this screening, three inorganic COPCs (arsenic, chromium, and lead) were retained for evaluation in each of the eight surface soil areas. In subsurface soil (outside the LF5a perimeter), only bis(2-ethylhexyl) phthalate was retained for evaluation. In subsurface soil (outside the LF5b perimeter), only barium was retained for further evaluation. In subsurface soil (inside LF5b perimeter, within a waste trench), eight COPCs, including

organochlorine pesticides, PCBs, and metals were retained. In sediment, 13 COPCs including VOCs, SVOCs, and organochlorine pesticides were retained. In surface water, three COPCs were retained. Attachment A4-1 summarizes the COPCs used in the ERA.

**Exposure Assessment.** The landscape at FEW is characterized as rolling shortgrass prairie with scattered rock outcrops. Situated among the extensive man-made facility infrastructure is a diversity of natural habitats, including shortgrass prairie, streams and riparian habitat, marshes, and wet meadows. The habitat at Zone B is primarily shortgrass prairie. Aquatic habitat in Zone B is limited to an intermittent unnamed tributary that joins Crow Creek approximately one mile downgradient of Zone B's eastern boundary.

Receptors considered for the ERA were identified on the basis of several criteria, including ecological or social significance, potential for exposure, and availability of toxicological data. The aquatic receptors included benthic invertebrates, fish, and aquatic biota. The terrestrial receptors included terrestrial plants, soil organisms, birds, and small mammals. The western meadowlark, horned lark, and deer mouse were used as surrogate receptors to represent small birds and mammals in the ecological effects assessment. The threatened Preble's meadow jumping mouse (*Zapus hudsonium preblei*) was not considered a receptor for the short grass prairie habitat in Zone B, as its range is restricted to the riparian zone bordering Crow and Diamond Creeks.

For the purpose of assessing risk, it was assumed that terrestrial plants were exposed to surface and subsurface soils; soil invertebrates, birds, and mammals were exposed to surface soil; benthic macroinvertebrates were exposed to sediments; and fish and aquatic biota were exposed to surface water. Exposure point concentrations for each chemical within each relevant exposure pathway were based on the maximum measured concentration and the 95% Upper Confidence Limit. Attachment A4-2 presents a summary of the ecological exposure assessment.

Ecological Effects Assessment. The potential for adverse ecological effects (i. e., risk) to a receptor from a COPC was determined by estimating the Hazard Quotient (HQ). HQs represent a comparison of the projected exposure level to what is considered to be the acceptable limit of exposure. An HQ greater than 1.0 indicates there is a potential risk. The following three assessment endpoints were evaluated using the HQ approach:

1. Are local populations of plants, soil invertebrates, birds, and small mammals using the shortgrass prairie being maintained?
2. Are populations of fish and aquatic biota inhabiting the water column in the Unnamed Tributary being maintained?
3. Are populations of benthic macroinvertebrates in the Unnamed Tributary sediments being maintained?

Attachment A4-2 includes a summary of the assessment and measurement endpoints chosen for this ERA.

**Ecological Risk Characterization.** Based on HQs calculated for receptors exposed to surface soil, arsenic may present a risk to the deer mouse. However, as a result of several compounding conservative assumptions used in the ERA, it appears that the small mammal population is unlikely to be at any risk from site-related metals. Avian receptors (represented by the western meadowlark and horned lark) are not at risk from the three inorganic COPCs found in surface soil.

Plants and terrestrial invertebrates in Zone B may be exposed to potentially toxic concentrations of chromium in surface soils. Plants in LF5b (inside LF5b perimeter, within a waste trench) also may be exposed to potentially toxic levels of boron and zinc in subsurface soil. However, the significance of these soil benchmark exceedances cannot be determined in view of the absence of background data for boron and the uncertainties

associated with the screening values and bioavailability of chromium and zinc.

In sediment, five organochlorine pesticides and toluene may present unacceptable risks to benthic macroinvertebrates based on exceedances of published or estimated sediment screening values. However, none of the organochlorine pesticides were detected in any samples of groundwater, the expected principal pathway from LF5a to LF5b to the Unnamed Tributary. Six other organic compounds in sediment do not exceed available sediment screening values and are unlikely to present an unacceptable risk. Trichlorofluoromethane has no sediment screening values for comparison with measured sediment concentrations and estimation of possible risk.

Based on the available sediment data, it is possible that the benthic macroinvertebrates are at some potential risk from five organochlorine pesticides and toluene, plus some unquantifiable risk from trichlorofluoromethane, for which there is no sediment benchmark.

In surface water there are three COPCs, of which barium may present an unacceptable risk to aquatic biota. Detected concentrations of barium are similar to concentrations in background groundwater. Of the two organics without surface water screening values (chloromethane and methylene chloride), chloromethane was not detected in groundwater and methylene chloride was detected in only 2 out of 72 samples. Discharge from groundwater is the expected principal exposure pathway from LF5a and LF5b to the Unnamed Tributary. Because no aquatic biota samples were collected from the Unnamed Tributary, the typical weight-of-evidence approach could not be used to supplement the chemical data collected.

In summary, it is possible that aquatic biota are at some potential risk from barium, plus some unquantifiable risk from chloromethane and methylene chloride for which there are no surface water benchmarks. However, based on the analysis of the data and the intermittent nature of the Unnamed Tributary, this potential risk is most likely minimal.

#### ***Basis for Remedial Action***

Results of the human health risk assessment indicated that on the basis of the concentrations, potential exposures, and toxicological characteristics of COPCs, there is no evidence of hazard/ risk to human health resulting from Zone B contaminants. Also, there is no basis for remedial action to address ecological risk because of the mitigating considerations (and uncertainties) of calculated risk. However, the concentration of TCE in the groundwater plume downgradient from LF5b exceeds the state and federal drinking water standard (MCL) of 5 ug/L. Remedial action is generally warranted when MCLs are exceeded. TCE is a potential carcinogen and is mobile in groundwater. Therefore, although there are no current or readily foreseeable users of the groundwater in Zone B, a conservative approach was directed, and the desire to restore the aquifer to drinking water standards was the basis for the remedial action. This will result in maximum protection of public health, welfare, and the environment from any actual or potential releases of hazardous substances from the site.

## **H. REMEDIAL ACTION OBJECTIVES**

The RAOs for Zone B include:

- Restoring the contaminated groundwater originating from LF5b to drinking water standards within a reasonable time frame.
- Incorporating the WCA into the final remedy to ensure that the planned landfill cover will prevent direct contact with non-hazardous waste and minimize infiltration of water through the waste materials.
- The key ARARs which drive RAOs are drinking water standards, which are the MCLs established under the Safe Drinking Water Act and the Wyoming Water Quality Rules and Regulations. Restoration is achieved when TCE and any of its degradation

products are reduced to their respective MCLs. The MCL for TCE is 5 ug/ L. Some of the degradation products have been found in Zone B, but to date none have been above their MCLs. These products and respective MCLs are cis-1,2-dichloroethylene (70 ug/L), trans-1,2-dichloroethylene (100 ug/L), and vinyl chloride (2 ug/L). Although the BRA identified no quantifiable risk from exposure to groundwater in Zone B, TCE is the most widespread groundwater contaminant in Zone B and was detected in several wells at concentrations above the MCL of 5 ug/L. Concentrations of TCE in groundwater will be reduced to the MCL of 5 ug/L.

Incorporating the WCA and the expected clean closure of LF5b into the final remedy ensures that the planned Resource Conservation and Recovery Act (RCRA) Subtitle D cover for the WCA will prevent any future contact with wastes and minimize infiltration and leaching. Clean closure status of LF5b will be determined once confirmatory data has been submitted to and accepted by EPA and WDEQ.

## **I. DESCRIPTION OF ALTERNATIVES**

Remedial alternatives evaluated for Zone B groundwater include: Alternative 1 - No Action, Alternative 2 - Institutional Controls, Alternative 3 - Natural Attenuation/Long-Term Monitoring (LTM), Alternative 4 - In Situ Permeable Reactive Barrier (PRB), Alternative 5 - Groundwater Extraction and Treatment. The numbered alternatives correspond with the alternatives in the FS (USAF 2000b).

### ***No Action***

As the name implies, the No Action alternative means no form of collection, treatment, access controls, or monitoring would be done for the plume at Zone B. This alternative is required to be included by the NCP to provide a baseline for comparison to other alternatives.

### ***Institutional Controls***

Institutional Controls are non-engineering methods intended to affect human activities in such a way as to prevent or reduce exposure to hazardous substances. These can include advisory notices (such as warning signs and deed notices) and legal actions which restrict land use such as zoning and local permitting, or ground water use restrictions. On many military installations such as FEW, these kinds of functions are served by the BGP, which describes current and planned land use and can also prohibit specified activities.

The USAF comprehensive planning process and BGP are similar to civilian local land use and planning processes, such as zoning, easements, rights- of- way, use of natural resources, and permitting for construction activities, such as digging. They have the effect of a direct order of the Secretary of the Air Force through a set of Air Force Instructions (APIs) and compliance is mandatory (e.g., AFI 33-360 and API 32-7062). The Installation Commander is responsible to ensure the comprehensive planning documents are developed, maintained and implemented. The Installation Commander must approve the BGP. A requirement of the APIs is to identify IRP sites (sites of known or potential contamination), where notes regarding specific institutional controls are placed as needed. These controls may be simply informational or serve as legal/management controls to restrict access, activities, and use of natural resources.

The institutional controls for the IRP sites at FEW will be enacted by modifying the BGP, either directly or through an addendum to the BGP (such as the Composite Constraints and Opportunities Plan [CCOP] which is a component of the BGP). Specific language will prohibit unauthorized access to the facilities for the remedy at the IRP site or use of natural resources. Known or possible areas of contamination will be placed on the Land Use Map. The BGP and Land Use Map will be updated as necessary, but no less than annually, to incorporate institutional controls and monitor their implementation and effectiveness. These controls cannot be removed without prior approval by the USAF (the Air Force

Remedial Project Manager or Chief of Compliance) with acceptance of the changes by EPA and WDEQ.

FEW is also currently developing an Environmental Restoration Land Use Control Plan (ERLUCP) that will clearly identify, delineate and describe areas that are subject to restrictions. Pertinent sections of this plan will be incorporated into the BGP.

Normal monitoring and operation and maintenance activities or other environmental activities conducted under plans accepted by EPA and WDEQ will be authorized activities. The BGP modifications will otherwise prohibit the use of ground water. Because municipal supplies are readily available, there are no current plans for use of ground water at FEW.

Modifications to the BGP will also prohibit access to facilities and construction or earth disturbances in certain areas (e. g., which would disturb the engineered cover on the WCA). In some cases, such as landfills which will remain in place in perpetuity, notices of the restrictions will be filed in the real property records in Laramie county. Fencing will be used as controls to prevent unauthorized access and potential exposure, in addition to minimizing potential exposures to humans, these restrictions will protect the facilities which are part of the remedy. Necessary activities can be conducted with approval of the USAF, generally in consultation with EPA and WDEQ. These may be addressed in the BGP or through the permitting process at FEW, which is required for digging and earth work. Some activities may be approved but require air monitoring or the use of personal protective equipment for workers or other constraints to assure worker health and safety requirements are met.

Advisory or informational controls will be used in addition to the legal/management controls. These include signs to identify access restrictions and warning of potential hazards in source areas. Also, community information and educational programs will enhance community understanding and awareness of the potential hazards.

Although considered unlikely, institutional controls would need to be revised in the event of property transfer. The installation was created by an act of Congress, and thus no conventional property deed exists. In the event of transfer, a deed with restrictive covenants may need to be created. CERCLA Section 120(h) requires the USAF to provide notice of hazardous substance releases and assurances that all remedial action has taken place or will be completed in any deed or transfer of property. To ensure this notice is given, the USAF prepares an Environmental Baseline Survey (BBS). Review of the BGP, IRP documents, and other information is required to complete the EBS. With the completion of the BBS, the property is categorized and thus determines whether the transaction may proceed and what type of restrictions may need to be imposed.

Revisions to the BGP that relate to Zone B will be incorporated after the Zone B ROD is final. At that time, a draft of the revisions will be provided to the RPMs for review and comment. After addressing comments, the revised BGP will be presented for approval to the Installation Commander during the annual review.

#### ***Monitored Natural Attenuation***

Natural Attenuation (also called Monitored Natural Attenuation) allows natural processes to address contaminants without added artificial treatment. Investigation and modeling during the remedial investigation and feasibility study have demonstrated these processes are occurring and will continue. Monitoring through time provides a control to assure the processes continue to attenuate the contaminants.

#### ***In Situ PRB***

PRBs consist of materials which are placed into the ground which contaminated ground water flows through. The PRB materials cause the contaminants to break down into less harmful by products. For TCE and related compounds, zero valent iron (iron filings) has been demonstrated to be effective.

## ***Groundwater Extraction and Treatment***

Extraction and Treatment, also known as 'Pump and Treat', is when contaminated ground water is pumped to the surface from wells, treated chemically or physically, and discharged. Refinements which may be needed during the life of the remedy include adjusting the number of extraction wells, adjusting pumping rates, pulsed pumping of some wells, or other adjustments to maximize treatment and cost-effectiveness. Monitoring may be needed post- pumping to ensure clean-up levels are maintained.

### ***Description of Remedy Components***

The following summarizes the major components of each alternative:

#### **Alternative 1 - No Action**

Baseline comparison alternative required by NCP - no components.

#### **Alternative 2 - Institutional Controls**

- Update of BGP, particularly the CCOP, to restrict use of groundwater, prohibit unauthorized access to facilities, prohibit construction or earth disturbances in certain areas (e. g., WCA) and allow limited activities in other areas.
- Review and approval or denial of construction work requests and digging permits by FEW Environmental Flight (such as where digging should be done only if personnel have the appropriate personal protective equipment (PPE)).
- Development of community information and educational programs by FEW

#### **Alternative 3 - Natural Attenuation/Long Term Monitoring**

- Natural attenuation of LF5b plume mass, toxicity, volume, and TCE contaminant concentration through advection, dispersion, volatilization, and adsorption
- Long-term (50 year) groundwater monitoring of chemicals and parameters to verify attenuation rates and mechanisms
- Also includes all institutional controls listed under Alternative 2

#### **Alternative 4 - In Situ PRB**

- Permeable wall containing a reactive medium (iron filings) to treat contaminants, installed to 40 feet bgs and perpendicular to groundwater flow direction; laboratory results, pilot demonstrations, and field- scale projects have shown PRB's are effective in treating TCE • PRB Monitoring and Maintenance Plan/ Program, including groundwater monitoring, for 25 years
- Location would be across entire plume external to the Unnamed Tributary, partially in an area of potential sensitive species habitat
- Also includes all institutional controls listed under Alternative 2

#### **Alternative 5 - Groundwater Extraction and Treatment**

- Extraction network, including an estimated 4 wells and associated piping designed to remove TCE contaminated groundwater from portions of the plume originating from LF5b that exceed the MCL (5 ug/L); the extraction wells radius of influences will cover the entire portion of contaminated groundwater that exceeds the MCLs

- Aboveground treatment system, including granular activated carbon (GAC) vessels and associated components to be determined during the design phase
- The discharge of treated water to the Unnamed Tributary via underground piping (within potential sensitive species habitat)
- Performance Monitoring - groundwater monitoring over a 7- year period, using a network of wells and treatment plant sampling points; the numbers and locations of wells and sampling points will be determined during the design phase
- Also includes all institutional controls listed under Alternative 2

#### ***Common Elements and Distinguishing Features of Each Alternative***

**Common Elements.** Because these alternatives will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment. Additionally, all of the alternatives except Alternative 1 - No Action would be subject to institutional controls. None of the alternatives would result in off-site discharge. As such, substantive requirements of permits would be met, but actual permits are not required.

For Alternatives 3, 4, and 5, proposed monitoring approaches are regarded as baseline assumptions for the purposes of scoping monitoring needs and to provide a basis for FS cost estimates. Actual monitoring needs would be evaluated as the design of the selected alternative progresses.

**Distinguishing Features.** The alternatives differ in their estimated costs and estimated time to achieve the RAOs or cleanup levels, as summarized in the following table:

<b>Alternative</b>	<b>Capital Cost 4</b>	<b>O&amp;M Cost</b>	<b>Site Cost Present Worth</b>	<b>Time to RAOs</b>
1. No Action 1	0	0	0	NA
2. Institutional Controls 1	\$20,467	\$29,029	\$35,623	NA
3. Natural Attenuation/Long-Term Monitoring 1,2,3	\$183,381	\$3,274,341	\$1,552,966	50 Years
4. In Situ Permeable Reactive Barrier 1,2,3	\$1,023,174	\$1,248,163	\$2,008,097	25 Years
5. Groundwater Extraction and Treatment 1,2,3	\$439,222	\$1,489,502	\$1,729,257	7 Years

#### **Notes:**

All costs were estimated using the Remedial Action Cost Engineering and Requirements (RACER) 2000 cost-estimating software.

- 1 Long-term monitoring and maintenance of the WCA is a cost (\$ 8.5 million) associated with all of the alternatives and is not included in the numbers presented.
- 2 Costs associated with long-term groundwater monitoring are typically included as part of the capital cost in RACER 2000. However, the monitoring costs were extracted and presented as operation and maintenance (O&M) for this analysis. The discount rate used to estimate present worth costs was 5%.
- 3 Institutional controls are a component of Alternatives 3, 4, and 5, and the associated cost is not included in the numbers presented.
- 4 Includes Remedial Design Costs.

Key ARARs for the alternatives would be distinguished in terms of discharges, waste management, and affects on sensitive species. None of these pertain to Alternatives 1 and 2. No discharges of treated water to the surface are involved for Alternatives 3 and 4,

but Alternative 5 would need to comply with the NPDES requirements as administered by WDEQ. Alternative 5 is the only alternative which requires off-site management of wastes, which in this case is minimal. However, transport and regeneration or disposal of the spent carbon used for treatment will need to comply with the Off-Site Rule. Potential impacts to sensitive species varies. Alternative 3 would require little or no disturbance to sensitive areas and disturbances from Alternative 5 would be minimal. Alternative 4 would disturb larger areas.

Institutional Controls as described in Alternative 2 will be reliable in the long term as long as the Air Force owns the property and can control land use. Alternatives 3, 4, and 5 all include constructed facilities. Construction for Alternative 3 is minimal, consisting of monitoring wells which can be reliably maintained and replaced at a low to moderate cost if needed. Alternative 5 will consist of monitoring and extraction wells, with a treatment system. Pumps and the treatment system are off the shelf materials and the technology and can be reliably maintained with minimal down time and low to moderate costs. Alternative 4 provides the greatest uncertainty because the treatment system is installed in the ground and all portions would not be readily accessible. PRBs are an innovative technology which has been used to effectively treat TCE and related compounds with the expectation of minimal operation and maintenance. Their use, however, is fairly recent and not widespread. Potential operational problems through time (such as formation of precipitates which reduce effectiveness and permeability) present a degree of uncertainty. Repair or replacement costs could vary greatly and would probably be moderate to high.

#### ***Expected Outcome of Each Alternative***

All of the ground water alternatives for the ground water plume associated with LF5b would result in a restored aquifer which meets drinking water standards for TCE and related degradation products with time frames ranging from a few years (Alternative 5) to upwards of 50 years (such as Alternative 3). Combined with the excavation of LF5b and it's expected clean closure, unlimited use of the LF5b area is expected. This is consistent with the current (and planned future) land use for open space, industrial, and helicopter landing pad. A possible exception is Alternative 4. The wall of iron filings is the only facility which cannot be dismantled. The necessary abandonment in place may limit construction in the immediate area due to geotechnical concerns. Alternative 4 is the only alternative currently considered to have a potentially significant impact on the habitat area of sensitive species. Regardless of the ground water alternatives, the WCA/LF5a area will be permanently identified as a landfill area, which will need to be maintained for the foreseeable future. Access to the area will need to be controlled and activities inconsistent with the operation and maintenance of the landfill prohibited under the BGP.

## **J. COMPARATIVE ANALYSIS OF ALTERNATIVES**

The five alternatives were compared with the nine EPA criteria established to evaluate remedial alternatives. The following paragraphs describe this evaluation, and Attachment 5 provides a summary table of the comparative analysis.

1. **Overall Protection of Human Health and the Environment.** Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

Alternatives 1 and 2 will not be protective of human health and the environment due to the lack of monitoring and/or management (institutional) controls. Alternatives 3, 4 and 5 would provide adequate protection from exposure to ground water contamination with a combination of monitoring and institutional controls. Alternative 3 may allow currently uncontaminated areas to become contaminated as the plume migrates and dissipates although no users currently exist in the plume

transport pathway. Alternative 4 actively treats the contaminants and assures reduced concentrations and harmless by-products in the transport pathway. Alternative 5 would provide control of plume migration through pumping.

Alternatives 1, 2, and 3 present minimal impact to the area which is potentially a habitat to sensitive species near the Unnamed Tributary to Crow Creek. Installing an underground discharge line through the area for Alternative 5 would result in some disturbance to the area and Alternative 4 presents the greatest impact.

2. **Compliance with ARARs.** Section 121( d) of CERCLA and NCP §300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other federal and state environmental statutes or provides a basis for invoking a waiver.

Because Alternatives 1 and 2 do not meet both of the threshold criteria, they cannot be used as remedies. They will therefore no longer be discussed in the continuing comparative analysis of alternatives. Alternative 3 would comply with the chemical-specific ARARs after a long period. Alternatives 4 and 5 would be able to meet all of the ARARs.

Habitat restoration to protect the continued existence of threatened or endangered species will be required of Alternative 4. The Air Force will consult with U. S. Fish and Wildlife Service to advise in meeting the requirements. Similar consultation will be needed with the Base Historic Preservation Officer and possibly the State Historic Preservation Officer.

Excavation to build the PRB in Alternative 4 would result in waste management of contaminated soils. Unless the wastes, which are expected to be non- hazardous, can be managed on-site (such as at the WCA), off-site disposal would be required. Wastes which test as hazardous would have to be disposed off-site. Transport and disposal of wastes off- site would comply with the requirements of the Off-Site rule (at 58 FR 49200, September 22, 1993 and 40 CFR Part 300.440). Spent carbon or any other residuals from the treatment system of Alternative 5 will need to be transported and disposed or regenerated in accordance with the Off Site Rule.

Discharge from Alternative 5 will meet the substantive discharge requirements of an NPDES permit as administered by WDEQ under the Wyoming Water Quality Rules and Regulations. WDEQ has proposed a change (to Chapter I, Section 18) which would result in the formal reclassification of Crow Creek. If promulgated, this will

result in a more stringent discharge limit for TCE and its degradation products to Crow Creek and possibly the other creeks on base. Carbon treatment is efficient and can be designed to comply with all existing and proposed limits for TCE and related degradation products.

3. **Long-Term Effectiveness and Permanence.** Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain on site following remediation and the adequacy and reliability of controls.

Alternative 3 would provide long-term effectiveness because the contaminant concentrations would be reduced to acceptable levels, but over a longer period of time. Effectiveness of the irreversible treatment of TCE and its degradation products (including cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride) is verified by monitoring.

Alternatives 4 and 5 provide the greatest long-term effectiveness and permanence. These alternatives use passive and active treatment technologies, respectively, to reduce risks. However, there is some potential for minimal residual risk in each alternative. Alternative 4 In-Situ PRB has the potential for the contaminated groundwater to bypass or flow under the PRB. Alternative 5 has residual carbon that contains contaminants. Alternative 4 passively treats the contaminated groundwater for 25 years. Alternative 5 actively extracts and treats the contaminated groundwater for a period of 7 years.

Reviews at least every five years, as required, would be necessary to evaluate the effectiveness of any of these alternatives because hazardous substances would remain on site in concentrations above health-based levels.

4. **Reduction of Toxicity, Mobility, and Volume through Treatment.** Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternatives 3, 4, and 5 address the total estimated volume of contaminated groundwater ( $1.735 \times 10^7$  gallons) and total estimated contaminant mass (2.2 pounds of TCE). These alternatives account for treatment of both TCE and its degradation products.

Alternative 3 relies on natural processes to reduce the contaminant concentrations and its associated degradation products. The natural processes are irreversible and no hazardous residuals would be produced. Alternatives 4 and 5 will most effectively reduce the toxicity, mobility, and volume of contaminants in groundwater. These alternatives include treatment processes that remove or destroy the contaminants in groundwater. Alternative 4 is an irreversible process that creates non-hazardous residuals. Alternative 5 involves extraction of the contaminated groundwater. The radius of influence of the extraction wells would capture the entire groundwater contaminant plume, thereby reducing the contaminant mobility. Extracted contaminated groundwater would be treated by adsorption of the contaminants onto GAC. The GAC would be a contaminated residual that is easily removed and destroyed by regeneration.

5. **Short-Term Effectiveness.** Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community and the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternative 3 involves minimal construction that would result in no short-term impacts to the community, workers, or the environment.

Alternatives 4 and 5 would have short-term impacts during construction. Alternative 4 involves disturbance of a larger area of land than Alternative 5. Part of the land disturbed by Alternative 4 is near a designated sensitive species habitat area. Alternative 4 may disturb a part of the sensitive habitat area by construction and operations. The habitat can be restored through time. Alternatives 3 and 5 will disturb little, if any of the sensitive habitat area. Impacts would be avoided through controls such as worker health and safety measures, reduction of fugitive dust, and mitigation of sensitive areas. Alternative 5, which involves installation of four wells, an aboveground treatment system, and discharge line to the Unnamed Tributary, has fewer short-term impacts during implementation than Alternative 4.

6. **Implementability.** Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Alternative 3 is relatively easy to implement. Conventional, reliable well installation techniques would be used. Equipment and materials are readily available. O&M would be minimal.

Alternative 5 is moderately difficult to implement in comparison to Alternatives 1, 2, and 3. Conventional and readily available equipment and materials would be used. GAC treatment is a proven technology and easy to operate and maintain. Off-site regeneration, disposal, and replacement services for the spent carbon are readily available.

Alternative 4 would be the most difficult of all the alternatives to implement. Conventional excavation methods would be used. However, the technology is currently considered an innovative process but has been used more frequently in the past several years. Thus its record of reliability is currently being evaluated. The PRB would be easy to operate and require minimal O&M. Alternative 4 would require treatability and extensive pre-design investigation work to determine operating parameters.

7. **Cost.** Alternative 4 has the highest capital cost associated with the installation and implementation of a PRB.

The present worth costs for Alternatives 3 through 5 range from \$1.55 to \$2.01 million. Alternative 4 has the highest present worth cost of \$2.01 million. Alternatives 3 and 5 have relatively close present worth costs at \$1.55 and \$1.73 million, respectively. Estimated costs exclude costs associated with the WCA. WCA costs are uniform for all five alternatives.

The table in Section I., above, presents estimated cost summaries for all alternatives.

8. **State/Support Agency Acceptance.** EPA and WDEQ support the preferred alternative without comment.
9. **Community Acceptance.** Neither oral nor written comments were received from the community during the public comment period and public meeting described in Section C.

## K. PRINCIPAL THREAT WASTES

There are no source materials that would be considered principal threats in Zone B. All waste from LF5b has been removed and relocated in the WCA, which will have a RCRA Subtitle D cap to prevent infiltration of water through deposited wastes. The TCE-contaminated groundwater plume originating from LF5b would not be considered a source material;

however, since it is the only potential threat to human health and the environment identified at the site, treatment will be used to reduce TCE levels below the MCL of 5 ug/L.

## **L. SELECTED REMEDY**

### **Summary of Rationale for Selected Remedy**

Based on consideration of the requirements of CERCLA, the detailed analysis of the five remedial alternatives, agency comments, and public comments, the USAF determined that Alternative 5: Groundwater Extraction and Treatment is the most appropriate remedy for OU8 groundwater at Zone B. The purpose of this response action is to reduce TCE concentrations to less than the drinking water standard of 5 ug/L. Based on the comparative analysis presented in Section J., above, Alternative 5 was selected as the RA at Zone B because it will provide the greatest overall benefits when evaluated against the nine criteria. It is the most cost-effective alternative that actively remediates the groundwater in the shortest amount of time. It is protective of human health and the environment and complies with all ARARs, including the substantive requirements of the National Pollutant Discharge Elimination System (NPDES) permit for discharging treated groundwater to Unnamed Tributary. Additionally, the proposed treatment system:

- Is easy to implement, operate, and maintain
- Reduces the toxicity, mobility, and volume of contamination through active treatment
- Is readily available from multiple sources
- Requires minimal pre- design investigation work
- Has minimal short- term impacts on workers and the community during construction and installation
- Achieves the groundwater RAO over the shortest period of time, approximately 7 years
- Is a cost- effective active treatment alternative

Based on information available at this time, the USAF, EPA, and WDEQ believe the Selected Remedy will be protective of human health and the environment, will comply with ARARs, will be cost effective and will use permanent solutions to the maximum extent possible. Because it will treat the contaminant present above regulatory levels, the remedy will also meet the statutory preference for the selection of a remedy that includes treatment as a principal element.

The following provides a description of the selected remedy for groundwater. Modifications may need to be made to the groundwater remedial design described depending on the outcome of future aquifer tests. After description of the selected groundwater remedy, a discussion that incorporates the WCA is provided.

### **Description of the Selected Remedy for Groundwater**

#### ***Extraction System***

To extract contaminated groundwater to approximately 45 feet bgs, a minimum of four 6-inch-diameter groundwater extraction wells would be screened from an estimated 5 to 45 feet bgs. Figure 8 depicts a conceptual layout of the extraction system. The actual locations will be determined during the design phase. Based on groundwater modeling results, the anticipated production rates for the extraction wells will range from 4 to 11 gallons per minute (gpm). The actual extraction rates will be determined during the design phase.

The extraction and treatment system will be designed to remove the high-concentration mass of contaminants along the center axis of the plume. All piping will be underground to prevent freezing and to maintain aesthetics.

#### ***Aboveground Treatment System and Discharge***

The anticipated influent flow rate at any one time is approximately 25 gpm and the treatment system will be designed to treat up to an estimated 30 gpm. The treatment plant will also be designed to treat the extracted groundwater to meet the RAOs and substantive requirements of an NPDES permit. The extracted groundwater will be pumped through GAC vessels that would be installed in series. As the lead GAC unit reaches its capacity for contaminant loading, it would be transported off site for regeneration or disposal. The GAC unit next in series would become the lead unit and a new GAC unit would be added. It is anticipated that one new unit would be replaced every 500,000 gallons and/or each year of operation. Following treatment, the effluent will be released to the Unnamed Tributary at a maximum estimated discharge rate of 30 gpm. A two-week start-up and testing period will be required.

The treatment plant will be placed next to Cheyenne Road in an enclosed treatment building. Electrical power will be obtained from an existing transformer or an existing electrical manhole located at the Defense Reutilization Marketing Office (DRMO) facility.

It is estimated that within the influence of the extraction system, it will take approximately 7 years of pumping with a minimum of four wells operating simultaneously to reduce aquifer TCE concentrations to less than 5 ug/L. However, because the concentrations in the aquifer are low and adsorption and diffusion-limited conditions may be achieved very quickly, if not immediately, pulsing may be needed.

#### ***Institutional Controls***

The BGP, associated CCOP, and ERLUCP will be modified to include verbiage specifically restricting the use of groundwater for consumptive or utilitarian purposes. The BGP will also include language to prohibit unauthorized access to facilities, prohibit construction or earth disturbances in certain areas (e. g., WCA) and allow limited activities in other areas through the review and approval of construction work requests and digging permits. Maps currently contained within the BGP and CCOP will be updated and areas of restricted use within Zone B will be clearly delineated.

#### ***Performance Monitoring***

A performance monitoring plan is a component of the groundwater extraction and treatment alternative. The performance monitoring plan will describe a groundwater monitoring program that is based on currently available site data and that extends over a 7-year period. The performance program will be reviewed and changed accordingly as new data are obtained during the 7-year operating and monitoring period. Long-term monitoring for the WCA will be incorporated into this performance plan.

**Performance Monitoring Goals.** The performance monitoring program goals at Zone B, will include:

- Monitor contaminant migration
- Monitor increases or decreases in contaminant concentrations
- Track changes in the shape, size, or position of the groundwater contaminant plume
- Assess the performance of groundwater extraction and treatment to reduce contaminant mass and minimize migration
- Optimize the groundwater extraction and treatment system performance

- Confirm system effluent standards are being met
- Assess the degree to which site-specific remediation goals are being met and evaluate the need for additional remediation
- Assess the degree to which potential receptors are being protected from contamination
- Assess the effectiveness of the institutional controls in preventing exposures and maintain facilities that assure effectiveness of the remedy

Community information and educational programs would be developed to enhance community understanding and awareness of the potential hazards posed by the source. The responsibilities of communities and individuals in the adherence to and maintenance of fencing or postings would be thoroughly discussed.

**Groundwater Monitoring Network.** The proposed performance monitoring network for the LF5b plume will consist of the following types of sample locations:

- Cross-gradient wells
- In-plume wells
- Downgradient wells
- Influent from each extraction well
- Effluent from treatment unit

The proposed monitoring network for the northern plume will consist of an estimated four groundwater monitoring wells including one upgradient, one downgradient, and two crossgradient wells.

At this time, no mandatory state guidelines for the types and placement of wells have been identified. No sampling points will be necessary for monitoring property boundaries or sensitive areas. Existing monitoring wells and treatment plant sampling points will be included in the performance well network and at least one new well will be added.

**Sampling Frequency and Duration of Monitoring.** The groundwater extraction and treatment system will be expected to achieve the operational goals in approximately 7 years. Therefore, the proposed performance monitoring program sampling frequency is based on a 7-year monitoring period. Sampling of the entire monitoring well network on a quarterly-basis is estimated during the first year in order to establish temporal (seasonal) and spatial variability. Following the first year, sampling of the well network annually is estimated for years 2 through 7. Aboveground treatment system samples will be collected routinely during the 7-year operational life of the treatment system.

**Analytical Protocol.** All sampled locations will be analyzed for the proposed analytical parameters listed in Attachment A6-1. At the time of the system start-up, additional samples will be analyzed for turbidity, alkalinity, aluminum, and VOCs. All sampling and analysis is performed in order to determine the groundwater extraction and treatment system's effectiveness at achieving remediation goals for the site, in addition to laboratory analysis for contaminants, groundwater elevations will be measured in monitoring well locations to aid in the evaluation of the system performance. Water quality parameters will be measured from monitoring well locations to verify that collected samples are taken from the same groundwater source.

**Data Management and Reporting.** An electronic data management program, coordinated with FEW, will be employed to facilitate effective management of the performance monitoring data for the project. This system will provide for efficient upload of field parameters and laboratory analytical data, basic quality assurance, routine data analysis, and reporting. The system will automate many of the routine tasks involved in data management. In addition, the data system will be linked to a GIS application in order to provide data mapping capabilities.

Performance monitoring reports will be generated in association with each sampling event. However, the O&M contractor will submit monthly operations memoranda with updated performance monitoring charts and, if necessary, recommendations for well pulsing. Periodic reviews will be conducted during the performance period to evaluate reporting requirements. FEW has a base-wide O&M contract that reports on each IRP site in a quarterly activities report.

**Performance Monitoring Plan Review.** The performance monitoring plan will be reviewed as necessary and revised to optimize the program. Groundwater and operational data collected during sampling events will be used as the basis for plan revisions. The sampling frequency and monitoring point locations will be evaluated using groundwater modeling or trend analysis to determine if a reduction in sampling events and locations can be implemented. Over time, plume shrinkage may require the elimination of monitoring points.

#### ***Summary of Estimated Remedy Costs***

Estimated costs for implementing the Selected Remedy for groundwater are:

Capital Cost	\$ 439,222
O&M Cost	\$1,489,502
Site Cost - Present Worth	\$1,729,257

Attachment 7-1 provides tables that present a more detailed estimated cost breakdown. The information in the cost estimate summary tables is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

#### ***Estimated Outcomes of the Selected Remedy for Groundwater***

The estimated outcome of the Selected Remedy includes:

- Use of Zone B for all current and future industrial and open space uses as described in the BGP
- Potential use of groundwater as a drinking water source upon achieving cleanup level for TCE after 7 years
- A final cleanup level for TCE in groundwater of 5 ug/L, to meet the MCL level

#### ***Incorporation of the WCA Remedy and Summary of Rationale***

The WCA is located atop and adjacent to the area of LF5a. LF5a was originally covered consistent with RCRA Subtitle D (and Wyoming Solid Waste Regulations). Because of its location and lack of associated releases, the LF5a area was chosen for the WCA. It is consistent with siting requirements, is relatively close to other landfills in the southern part of the base, and is accessible by existing roads. There have been no associated TCE plumes and little if any leachate generation, probably due to greater amounts of finer materials in the underlying geology. The WCA location provides the Air Force with a means to address the greatest volume of wastes on site while achieving cost-effectiveness through an economy of scale. It also allows restoration of areas where other older landfills have wastes in contact with ground water or threaten surface water quality on base.

The WCA was originally constructed as a removal action. Covering the landfill materials is consistent with the presumptive remedy approach. The WCA was analyzed and designed to be consistent with potential final remedies. Additional information can be found in the Engineering Evaluation/Cost Analysis (EE/CA) (USAF 1999a). Only non-hazardous wastes are allowed in the WCA. Wastes which test as hazardous must be managed appropriately and

disposed off-site. Construction of the cap complies with RCRA Subtitle D (and Wyoming Solid Waste) requirements. Wastes from Landfills 2a/2b, LF3, and LF5b have been placed in the WCA to date.

### **Description of the WCA Remedy**

The WCA consolidates nonhazardous waste from LF5a and other excavated landfills including LF5b, LF2a, LF2b, and LF3.

Major components of the WCA include cover construction, a performance monitoring system, and institutional controls.

#### ***Cover Construction***

An earthen cover estimated to be completed in July 2001 will consist of the following from top to bottom:

- Multiple cool and warm season grasses and forbs in a six- inch topsoil layer
- A minimum of 24 inches of low-permeability cover soil, called an infiltration barrier layer in Wyoming Sanitary Landfill regulations (WDEQ 1998)
- A minimum of six inches of grading fill soil

#### ***Institutional Controls***

After completion of the WCA, institutional controls will be implemented to limit direct exposure to landfill contents and contaminated soils, and to protect the integrity of the selected remedy. Refer to Section I for a comprehensive discussion of institutional controls. Institutional controls will include the following:

- The BGP will include language to prohibit unauthorized access to facilities, prohibit construction or earth disturbances in certain areas and allow limited activities in other areas through the review and approval of construction work requests and digging permits
- Maps currently contained within the BGP will be updated and areas of restricted use within Zone B will be clearly delineated
- Filing notice of these restrictions in the real property records for the county in which the WCA is located after completion of the WCA construction. Before property transfer, the USAF will provide a deed covenant notifying the transferee of the locations of, and restriction on, use of the area
- Fencing the WCA area and placing warning signs

#### ***Performance Monitoring***

After completion of the cover, the WCA will be inspected. The inspections are anticipated to begin in August 2001, after completion of the WCA cover. Inspections will address performance/conditions of the following:

- Cover system
- Run-on/run-off control system
- Facility access control system
- Groundwater monitoring well network (within covered area)

Photographs and maps will be produced as part of performance monitoring to document overall performance and areas in need of improvement. Groundwater monitoring will also occur in approximately six wells.

The length of the monitoring program will extend over a 30- year period. The performance program will be reviewed and changed accordingly as new data are obtained during the 30-year monitoring period.

**Performance Monitoring Goals.** The main objective of the Removal Actions and construction of the WCA is to minimize environmental impacts associated with the waste by:

- Eliminating direct contact with the landfill contents
- Minimizing the amount of moisture that infiltrates the cover system
- Controlling surface water ponding
- Monitoring groundwater for applicable compounds
- Verifying the integrity of physical institutional controls
- Documenting establishment of desirable native vegetation
- Assess the effectiveness of the institutional controls in preventing exposures and maintain facilities which need to be maintained to assure effectiveness of the remedy

**Groundwater Monitoring Well Network.** The proposed performance monitoring network will consist of upgradient, cross-gradient and downgradient wells. Groundwater monitoring will be conducted in approximately six groundwater monitoring wells.

**Sampling Frequency and Duration of Monitoring.** The proposed performance monitoring program sampling frequency is based on a 30- year monitoring period. Visual inspections will be conducted at a schedule similar to:

- Monthly for the first year
- Annually for Years 2-30

Monitoring for methane in the methane probes will be conducted at a schedule similar to:

- Quarterly for the first year
- Annually for Years 2-30

Groundwater monitoring will occur at the intervals detailed in the Zone B- Groundwater Remedial Action Plan at a schedule similar to:

- Quarterly for the first year
- Annually for Years 2-30

**Analytical Protocol.** All sampled locations will be analyzed for the proposed analytical parameters listed in Attachment A6-2. In addition to laboratory analysis for contaminants, groundwater elevations will be measured in monitoring well locations. Water quality parameters will be measured from monitoring well locations to verify that collected samples are taken from the same groundwater source.

**Data Management and Reporting.** An electronic data management program, coordinated with FEW, will be employed to facilitate effective management of the performance monitoring data for the project. This system will provide for efficient upload of field parameters and laboratory analytical data, basic quality assurance, routine data analysis, and reporting. The system will automate many of the routine tasks involved in data management. In addition, the data system will be linked to a GIS application in order to provide data mapping capabilities.

Performance monitoring reports will be generated in association with each monitoring and/or sampling event. Periodic reviews will be conducted during the performance period to evaluate reporting requirements. FEW has a base-wide O&M contract that reports on each IRP site in a quarterly activities report.

**Performance Monitoring Plan Review.** The performance monitoring plan will be reviewed as necessary and revised to optimize the program. Data collected during monitoring and/ or sampling events will be used as the basis for plan revisions. The visual observation frequency, sampling frequency, and monitoring point locations will be evaluated using modeling or trend analysis to determine if a reduction in monitoring and/or sampling events and locations can be implemented.

#### ***Summary of Estimated WCA Remedy Costs***

Estimated costs for implementing the remedy for the WCA are:

Capital Cost	*
Total O&M/LTM Costs	\$8,575,391
Periodic Costs	\$ 136,272
Total Cost in Current Dollars	\$8,651,669

\*Capital costs have been addressed under previous projects.

Attachment A7-2 provides tables that present a more detailed estimated cost breakdown. The information in the cost estimate summary tables is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

#### ***Estimated Outcomes of the WCA Remedy***

The estimated outcome of the Selected Remedy includes:

- The WCA will be a permanent waste management area which will require long term operation and maintenance and monitoring.
- LF5b will be clean closed, allowing unlimited exposure and unrestricted access to the area. The same is expected for Landfills 2a, 2b, and 3.

### **M. STATUTORY DETERMINATIONS**

Under CERCLA §121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

#### **Protection of Human Health and the Environment**

Alternative 5 will protect human health and the environment by treating TCE-contaminated groundwater using groundwater extraction wells and a treatment system. The RA will reduce TCE concentrations in groundwater to MCLs as the extraction and treatment induces water flow through the aquifer, replacing contaminated water with "clean" water. Currently, groundwater at Zone B is not being used. There will be minimal risk to human health and the environment during construction, operation, and maintenance of the treatment system. Strict adherence to health and safety protocols and monitoring will minimize risk from VOCs, dust, and noise. Erosion control barriers will be used to prevent surface runoff to the Unnamed Tributary, and consultation with the U. S. Fish and Wildlife Service (USFWS)

will be conducted so that no adverse impacts occur in any sensitive species habitat.

Protection of human health and the environment at the WCA will be achieved through construction of a low-permeability cover, which will prevent exposure through contact and minimize contaminant mobility in wind and water. The design of the WCA has been outlined in the Zone B Feasibility Study Report, Section 1.2.5.1, WCA Design. This will result in clean closure of LF5a and minimize risks below the 10<sup>-4</sup> to 10<sup>-6</sup> acceptable risk range, with a Hazard Index well below 1.

#### **Compliance with ARARs**

The groundwater extraction and treatment system will comply with all ARARs. The ARARs are briefly described below and are presented in more detail in Attachment 8, which also lists other criteria, advisories, or guidance to be considered (TBCs) for this RA.

ARARs pertaining to the WCA were identified in an Action Memorandum (USAF 2000c) and are included as Attachment A8-4 of this ROD. Key ARARs include RCRA Subtitle D and the corresponding state rules.

#### ***Chemical-Specific ARARs***

Chemical-specific federal ARARs for groundwater include the following:

- **Safe Drinking Water Act (SOWA), 40 CFR, Subparts B, F, and G.** Provides MCLs and MCL goals for select chemicals in drinking water. Primary drinking water regulations include health-based allowable concentrations of carcinogens and non- carcinogens in drinking water sources.

Chemical-specific Wyoming State ARARs for groundwater include the following:

- **Wyoming Environmental Quality Act/Wyoming Air Quality Standards and Regulations.** Provide air emission standards for various chemicals and compounds, including fugitive emissions.
- **Wyoming Environmental Quality Act/Wyoming Water Quality Rules and Regulations.** Provide standards for protection of surface water and groundwater.
- **Wyoming Hazardous Waste Rules and Regulations.** Identify and list hazardous wastes.

#### ***Action-Specific ARARs***

Action-specific federal ARARs for groundwater include the following:

- **Clean Water Act (CWA), 33 U. S. Code (USC) 1251 et seq.** Provides criteria and chemical standards for discharge of pollutants into waters of the United States. Sets requirements for the control of stormwater runoff.
- **Clean Air Act 40 CFR Part 50.** Establishes standards for ambient air quality to protect public health and welfare.

The principal action-specific Wyoming State ARARs for groundwater include the following:

- **Wyoming Environmental Quality Act.** Provides requirements for discharge into waters or emission of air contaminants.
- **Wyoming Water Quality Rules and Regulations.** Provide regulations for discharges to waters of the state, including both surface and ground waters.
- **Wyoming Air Quality Standards and Regulations.** Provide standards for control of emissions, including particulates and odors. Include requirements for construction, modification, and operation.
- **Wyoming Hazardous Waste Rules and Regulations.** Provide standards for hazardous waste generators, transporters, and interim status standards for owners or operators of hazardous waste treatment, storage, and disposal facilities that also apply to short-term storage of hazardous waste.

- **Wyoming Solid Waste Management Rules and Regulations.** Prohibit dumping of non-hazardous solid waste (i. e., trash) on the site.

#### ***Location-Specific ARARs***

Location-specific federal ARARs for groundwater include the following:

- Clean Water Act–Dredge and Fill Regulations
- Endangered Species Act
- Fish and Wildlife Coordination Act
- Migratory Bird Treaty Act
- National Historic Preservation Act
- Archaeological and Historical Data Preservation Act
- Archaeological Resources Protection Act (1979)

There are also two federal TBCs:

- EO11990–Protection of Wetlands
- EO 11988–Protection of Floodplains

The principal location-specific state ARARs for groundwater include the following:

- **Wyoming Water Quality Rules and Regulations.** Provide water quality standards for groundwater and surface waters based on the particular stream segment and provide for protection of wetlands.

#### **Cost Effectiveness**

In the lead agency's judgment, the Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430(f)(1)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence this alternative represents a reasonable value for the money to be spent.

The estimated present worth cost of the Selected Remedy is \$1,729,257. Although Alternative 3 is \$176,291 less expensive, it requires 50 years to meet the RAO of 5 ug/L TCE. The Selected Remedy's additional cost provides a significant decrease in time to meet RAOs and protect human health and the environment and is cost-effective. Attachment A9 summarizes the cost-effectiveness comparison among alternatives.

#### **Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable**

The USAF has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site. The Selected Remedy treats the chemical of concern (TCE), achieving a permanent reduction of TCE concentration in the Zone B groundwater plume to below 5 ug/L. Of those alternatives that are protective of human health and the environment and comply with ARARs, the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria.

#### **Preference for Treatment as a Principal Element**

The Selected Remedy will treat contaminated groundwater. Therefore, the statutory preference for remedies that employ treatment as a principal element is satisfied.

While the WCA does not utilize treatment, it utilizes containment as an engineering control to prevent exposure and minimize transport of contaminants.

#### **5-Year Review Requirement**

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

#### **N. DOCUMENTATION OF SIGNIFICANT CHANGES FROM PREFERRED ALTERNATIVE OF PROPOSED PLAN**

The Proposed Plan for the ROD was released for public comment December 20, 2000. The preferred alternative identified in the Proposed Plan was a groundwater extraction and treatment system, which was determined to be protective of human health and the environment. Additionally, the Proposed Plan incorporates the WCA and the expected clean closure of LF5b into the final remedy. The USAF, EPA, and WDEQ reviewed all written and verbal comments submitted during the public comment period. There were no significant changes to the preferred alternative.

**III. RESPONSIVENESS SUMMARY  
FOR THE RECORD OF DECISION  
REMEDIAL ACTION AT ZONE B: OPERABLE UNIT 8, LANDFILL 5  
F. E. WARREN AIR FORCE BASE**

**A. STAKEHOLDER ISSUES AND LEAD AGENCY RESPONSES**

At the time of the Record of Decision (ROD) public comment period, the preferred alternative for the Selected Remedy at Zone B had been identified by the United States Air Force (USAF), with U. S. Environmental Protection Agency (EPA) and Wyoming Department of Environmental Quality (WDEQ) concurrence. The Selected Remedy, groundwater extraction and treatment, was presented in the Proposed Plan as the preferred alternative. Based on the public's response and comments received during the public comment period for the ROD, there were no significant objections to the preferred alternative as presented.

Community interest in Comprehensive Environmental Response and Compensation and Liability Act (CERCLA) and Installation Restoration Program (IRP) activities at F. E. Warren Air Force Base (FEW) has fluctuated over the years since the initial record search and personnel interviews conducted for the USAF in September 1985. No specific individuals or organizations have been consistently involved over this period, although many groups and individuals have been involved during the life of the project. There were no concerns expressed during the Zone B RI or on the FS Report before the public comment period for the ROD.

Restoration Advisory Board (RAB) meetings, which are open to the public, have been conducted since January 31, 1995. RAB members include representatives from the community and from city and county government, with a community or local government member as the co-chair. The RAB meetings have varied in frequency from monthly to quarterly depending on the level of activity and RAB member interest. The preferred alternative for Zone B was identified to the RAB in the 14 November 2000 RAB meeting. The RAB members offered no comments regarding the alternatives.

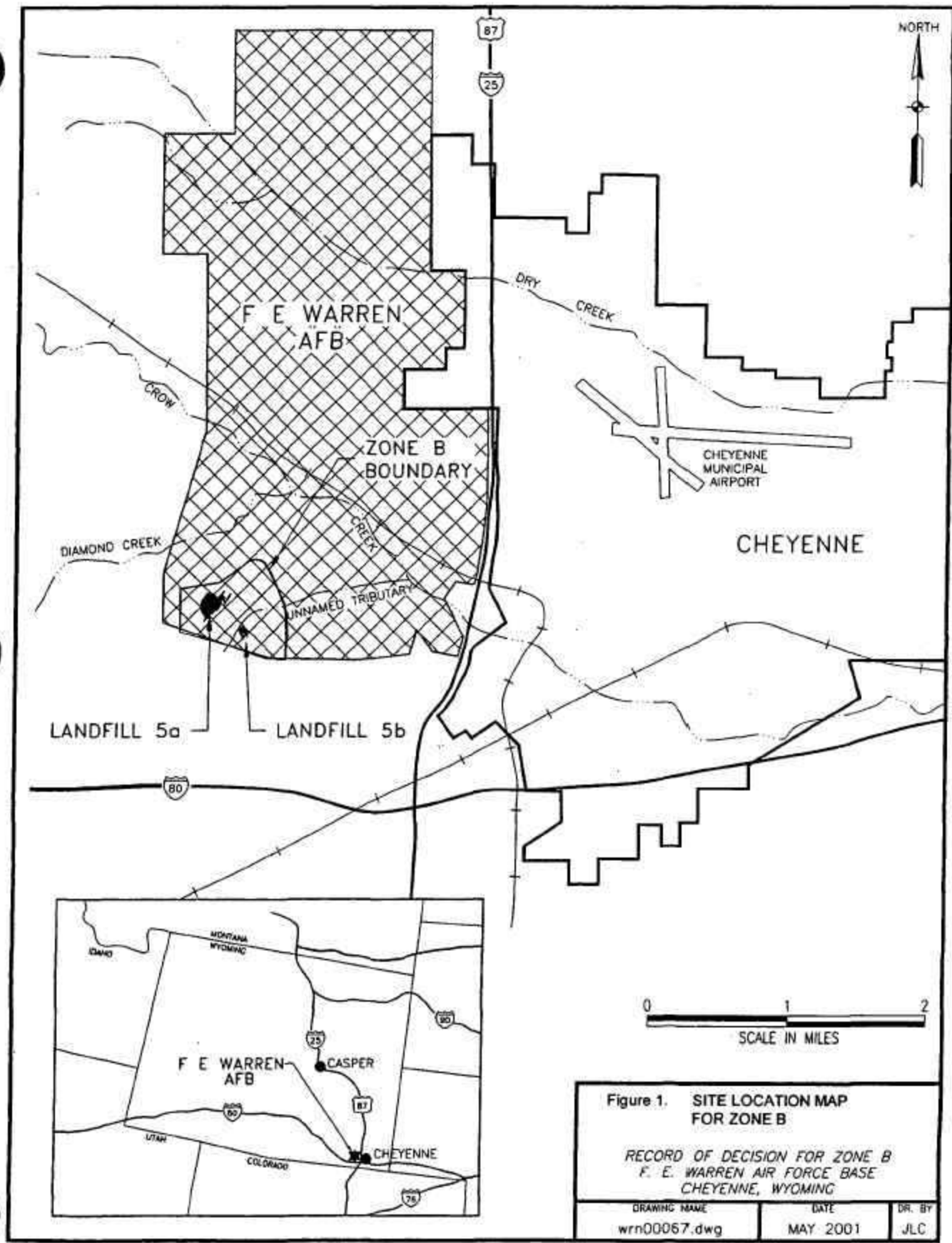
The public comment period on the Proposed Plan for the Zone B, Operable Unit 8 (OUS) Remedial Action (RA) at FEW was held from December 20, 2000 to January 19, 2001. The public meeting was held on 9 January 2001 and attended by one member of the public. No comments were received during the public comment period or public meeting.

**B. TECHNICAL AND LEGAL ISSUES**

No technical and legal issues were identified with the Zone B Proposed Plan and Selected Remedy.

## REFERENCES

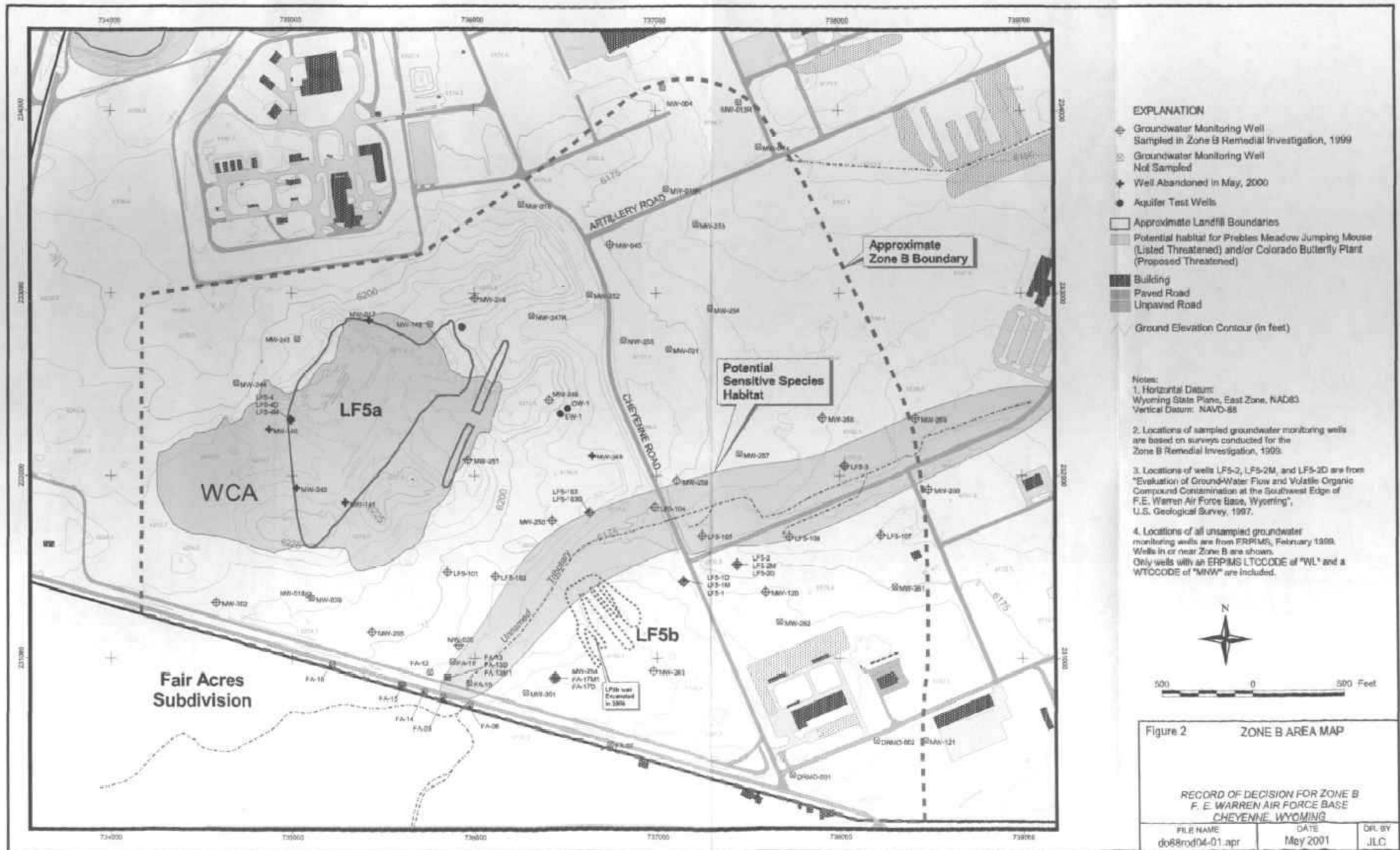
- Air Force Instruction (API) 32-7062, Air Force Comprehensive Planning, 01 October 1997.
- API 33-360, Volume 1, Publications Management Program, 31 July 1998.
- Crist, M. A. 1985. *Altitude and Configuration of the Water Table, and Depth to Water Near Cheyenne, Wyoming*, May 1984: U. S. Geological Survey Water Resources Report 85- 4154.
- Engineering Science. 1985. *Installation Restoration Program Phase I: Records Search, F.E. Warren Air Force Base, Wyoming*. Atlanta, Georgia.
- Radian International. 2000. *Waste Co-Location Area Design, Volume 1, Design Analysis Report, Volume 2, Design Drawings, Volume 3, Technical Specifications, Volume 4, Post-Closure Monitoring and Maintenance Plan*. F.E. Warren AFB, Cheyenne, Wyoming. February.
- United States Air Force (USAF). 2000a (April). *Remedial Investigation Report, Remedial Investigation/Feasibility Study, Proposed Plan, and Record of Decision for Zone B*. F.E. Warren AFB, Cheyenne, Wyoming.
- \_\_\_\_\_. 2000b. *Feasibility Study Report for Zone B*. F.E. Warren Air Force Base, Cheyenne, Wyoming.
- \_\_\_\_\_. 2000c. *Action Memorandum, Removal Action at OU9, Landfills 2a and 2b; OU11, Landfill 3; and OU8, Landfill 5b*. F.E. Warren Air Force Base.
- \_\_\_\_\_. 1999a. *Engineering Evaluation/Cost Analysis, Landfill 2A/2B; Landfill 3; and Landfill 5b*. F. E. Warren Air Force Base.
- \_\_\_\_\_. 1999b (February). *Baseline Risk Assessment Scoping Document*, F.E. Warren Air Force Base, Cheyenne, Wyoming.
- \_\_\_\_\_. 1995 (July). *Focused Remedial Investigation at F.E. Warren Air Force Base, Wyoming*. Final Report.
- \_\_\_\_\_. 1991. *Remedial Investigation for F.E. Warren Air Force Base, Cheyenne, Wyoming*. U.S. Geological Survey Administrative Report, v. 1-5.
- United States Environmental Protection Agency (EPA). 2000a. (February). *Integrated Risk Information System (IRIS)*. On-line database.
- \_\_\_\_\_. 2000b. (February). *EPA Region III Risk-based Concentration Table*.
- \_\_\_\_\_. 1998. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual*. Supplemental Guidance, Dermal Risk Assessment. Interim Guidance.
- \_\_\_\_\_. 1997. (July) *Health Effects Assessment Summary Tables (HEAST) FY1997 Update*. Office of Research and Development. USEPA. Washington D.C.
- United States Geological Survey (USGS). 1967. *Geology and Groundwater Resources of Laramie County, Wyoming*. Geological Water Supply Paper 1834.
- Wyoming Department of Environmental Quality. 1998. *Wyoming Solid Waste Rules and Regulations*. Chapter 2. Sanitary Landfill Regulations. October.

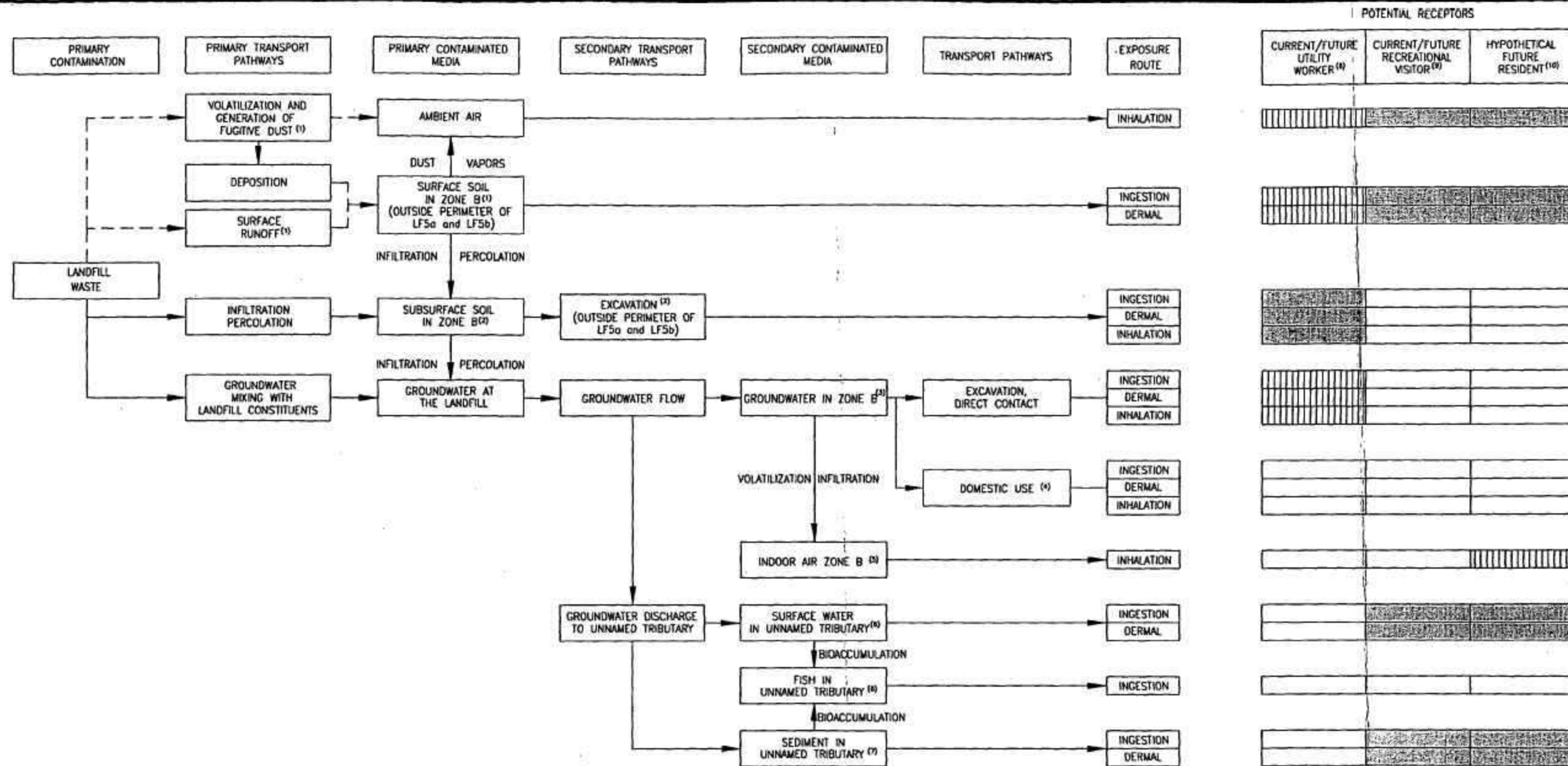


# Color Map(s)

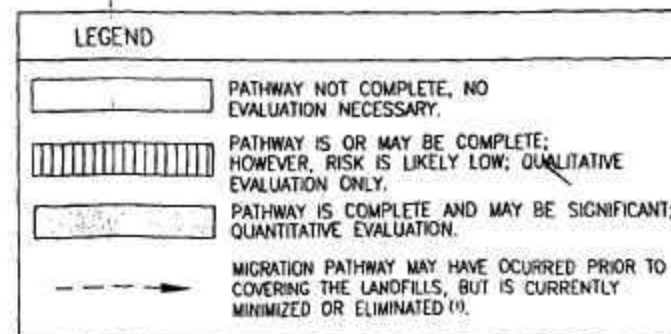
The following pages  
contain color that does  
not appear in the  
scanned images.

To view the actual images, please  
contact the Superfund Records  
Center at (303) 312- 6473.





- (1) LANDFILL 5A HAS A COMPRESSED CLAY SOIL COVER TOPPED BY A LAYER OF VEGETATED TOPSOIL. LANDFILL 5B IS COVERED WITH VEGETATED TOPSOIL. THEREFORE SURFACE RUNOFF, VOLATILIZATION, AND FUGITIVE DUST GENERATION FROM THE WASTE ITSELF ARE MINIMIZED OR ELIMINATED. PRIOR TO COVERING, CONTAMINANTS MAY HAVE MIGRATED OFF THE SURFACE OF THE LANDFILLS TO AREAS OUTSIDE THEIR PERIMETER. THE TOPSOIL CURRENTLY COVERING THE LANDFILL IS ASSUMED TO BE UNCONTAMINATED.
- (2) IT IS ASSUMED THAT POTENTIAL RECEPTORS DO NOT DIG INTO THE TRENCHED WASTE ITSELF, BUT MAY BE EXPOSED TO SUBSURFACE SOIL OUTSIDE THE PERIMETER OF THE LANDFILL.
- (3) DUE TO THE LOCATION OF ZONE B AND THE GROUNDWATER FLOW DIRECTION, CONTAMINANT MIGRATION IN GROUNDWATER TO OFF-SITE LOCATIONS IS NOT LIKELY TO OCCUR.
- (4) FUTURE GROUNDWATER USE AS A DRINKING WATER SOURCE IS NOT LIKELY TO OCCUR.
- (5) THIS MIGRATION PATHWAY WAS EVALUATED USING A VOLATILIZATION MODEL; HOWEVER, ESTIMATED INDOOR AIR CONCENTRATIONS DID NOT EXCEED EPA REGION 3 AMBIENT AIR RBCS.
- (6) THE UNNAMED TRIBUTARY IS AN INTERMITTENT STREAM THAT DOES NOT CONTINUOUSLY SUPPORT AQUATIC BIOTA. IT DISCHARGES TO CROW CREEK MORE THAN A MILE FROM THE LANDFILL.
- (7) THERE WERE NO HUMAN HEALTH COPCS IDENTIFIED IN THE SEDIMENT MEDIUM.
- (8) CURRENT/FUTURE UTILITY WORKER ASSUMED TO WORK (E.G., EXCAVATING SOIL TO REPAIR UNDERGROUND PIPELINE) IN ZONE B, BUT NOT ON LANDFILL ITSELF.
- (9) CURRENT/FUTURE RECREATIONAL VISITOR ASSUMED TO OCCASIONALLY VISIT UNNAMED TRIBUTARY AND ADJACENT AREAS IN ZONE B.
- (10) HYPOTHETICAL FUTURE RESIDENT ASSUMED TO LIVE IN ZONE B, BUT NOT ON THE LANDFILL ITSELF.

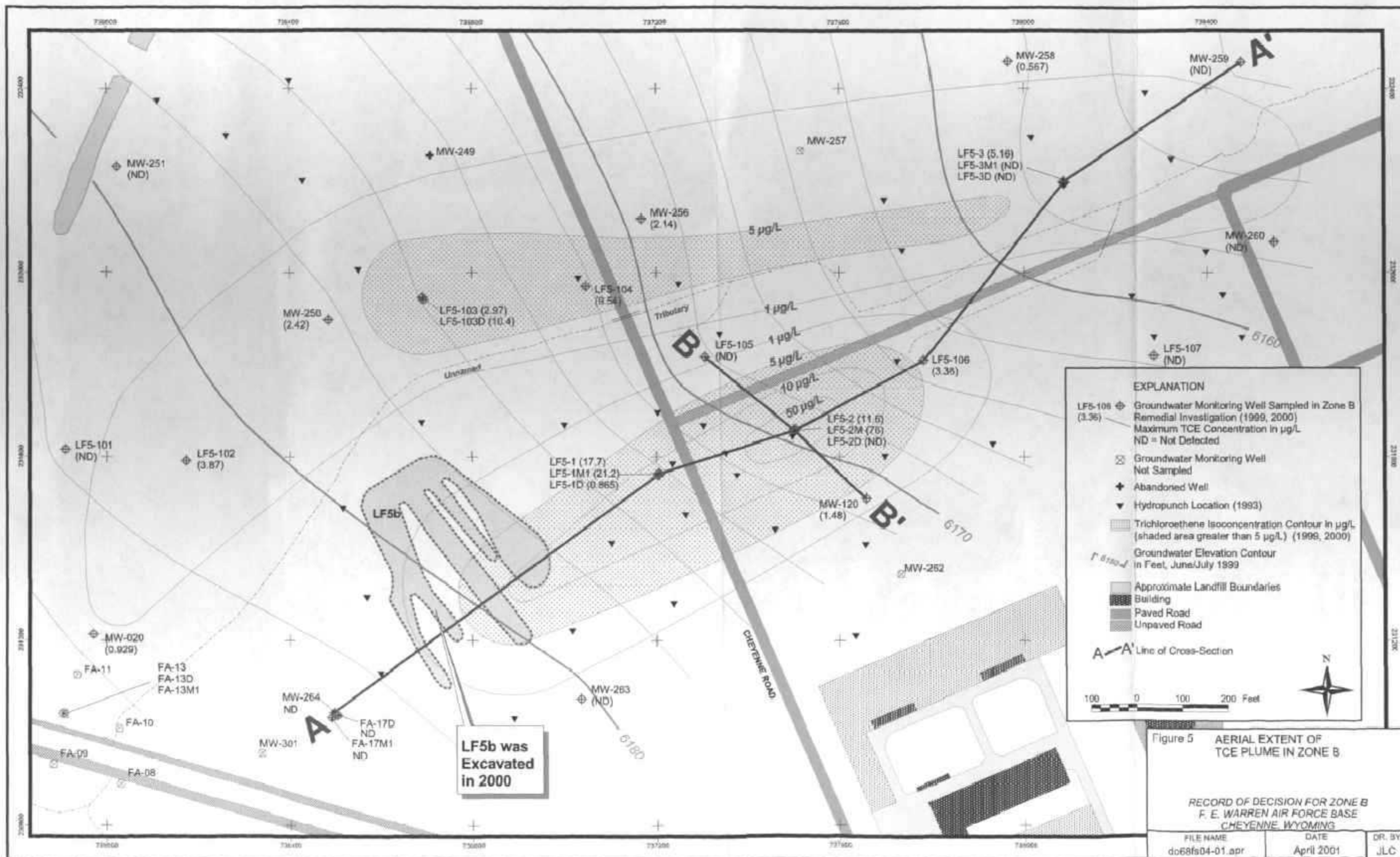


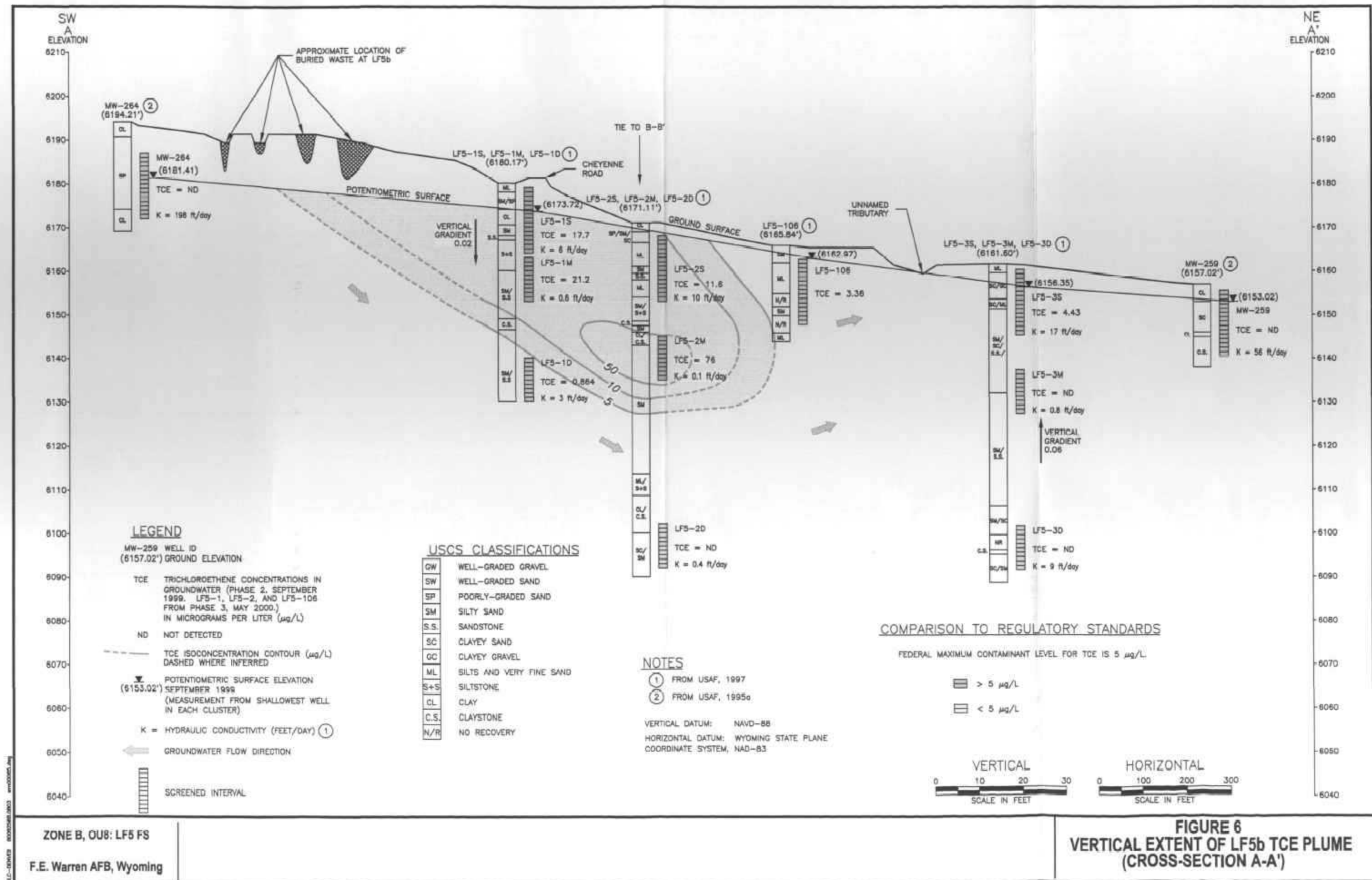
ZONE B: OUB, LF5 ROD

F.E. Warren AFB, Wyoming

**Figure 3**  
**HUMAN HEALTH CONCEPTUAL SITE MODEL**







# LEGEND

LF5-105 WELL ID  
(6164.34') GROUND ELEVATION

TCE TRICHLOROETHENE CONCENTRATIONS  
IN GROUNDWATER (PHASE 2,  
SEPTEMBER 1999. LF5-1 FROM  
PHASE 3, MAY 2000.)  
IN MICROGRAMS PER LITER ( $\mu\text{g/L}$ )

ND NOT DETECTED

? --- TCE ISOCONCENTRATION CONTOUR  
( $\mu\text{g/L}$ )  
DASHED WHERE INFERRED  
QUERIED WHERE UNCERTAIN

▼ POTENTIOMETRIC SURFACE ELEVATION  
(6173.65')  
SEPTEMBER 1999  
(MEASUREMENT FROM SHALLOWEST WELL  
IN EACH CLUSTER)

K = HYDRAULIC CONDUCTIVITY (FEET/DAY) ①

⊗ LITHOLOGIC LOG NOT AVAILABLE

SCREENED INTERVAL

## USCS CLASSIFICATIONS

GW	WELL-GRADED GRAVEL
SW	WELL-GRADED SAND
SP	POORLY-GRADED SAND
SM	SILTY SAND
S.S.	SANDSTONE
SC	CLAYEY SAND
GC	CLAYEY GRAVEL
ML	SILTS AND VERY FINE SAND
S+S	SILTSTONE
CL	CLAY
C.S.	CLAYSTONE
N/R	NO RECOVERY

## NOTES

① FROM USAF, 1997

VERTICAL DATUM: NAVD-88

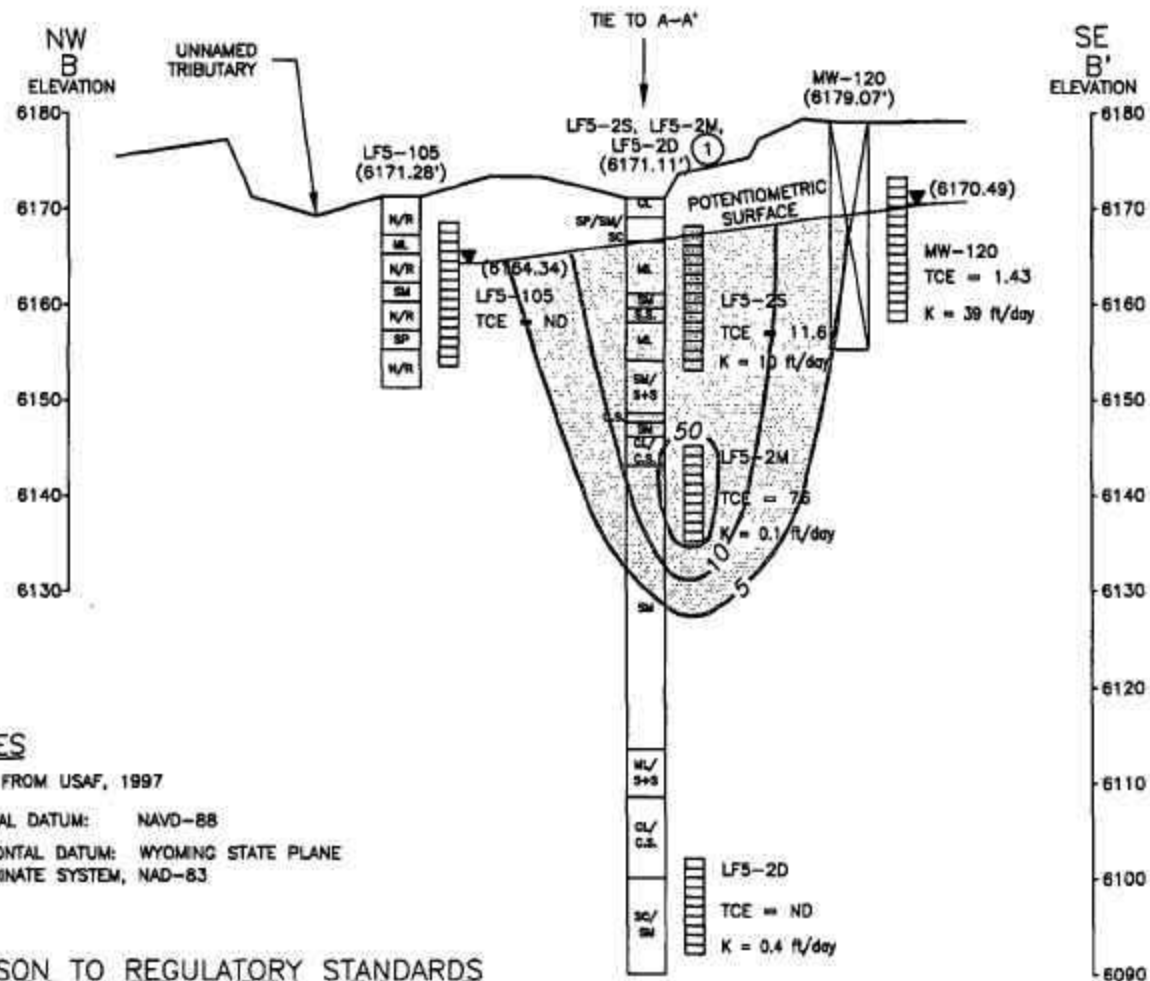
HORIZONTAL DATUM: WYOMING STATE PLANE  
COORDINATE SYSTEM, NAD-83

## COMPARISON TO REGULATORY STANDARDS

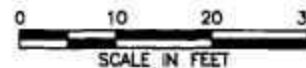
FEDERAL MAXIMUM CONTAMINANT LEVEL FOR TCE IS  $5 \mu\text{g/L}$

☐  $> 5 \mu\text{g/L}$

☐  $< 5 \mu\text{g/L}$

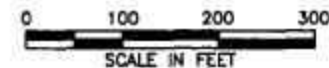


VERTICAL



SCALE IN FEET

HORIZONTAL



SCALE IN FEET

ZONE B, OU8: LF5 FS

F.E. Warren AFB, Wyoming

FIGURE 7  
VERTICAL EXTENT OF LF5b TCE PLUME  
(CROSS-SECTION B-B')

## **ATTACHMENT A1**

### **Selection of Human Health COPCs for Surface Water Human Health Risk Assessment**

**TABLE A1-1**  
**SELECTION OF HUMAN HEALTH COPCs FOR SURFACE WATER**  
**HUMAN HEALTH RISK ASSESSMENT**  
**ZONE B, OU8, LF5 RI, F.E. WARREN AFB**

Detected chemicals	Is the chemical an essential nutrient?	Is toxicity information available?	Site Significantly Exceeds Background?	Other evidence showing chemical is not site related? (1)	Number of detections	Number of samples	Is detection frequency >5%?	Maximum Detected Value (mg/L)	Toxicity Screening Value (mg/L)	Maximum detected value > toxicity screening value?	95% UCL	95% UCL > toxicity screening value?	COPC?
<b>Volatiles</b>													
Chloroethane	No	--	--	--	2	6	Yes	0.000583	0.0036	No	--	--	No
Methylene chloride	No	--	--	--	3	6	Yes	0.00315	0.0041	No	--	--	No
Trichloroethene	No	--	--	--	2	6	Yes	0.00177	0.0016	Yes	--	--	Yes
<b>Inorganics</b>													
Aluminum	No	--	No	--	1	6	--	--	--	--	--	--	No
Barium	No	--	Yes	--	6	6	Yes	0.29	0.26	Yes	0.26542	Yes	Yes
Calcium	Yes	Yes	Yes	--	6	6	Yes	119	51.1	Yes	117.061	Yes	Yes
Iron	Yes	Yes	No	--	2	6	--	--	--	--	--	--	No
Magnesium	Yes	Yes	No	--	6	6	--	--	--	--	--	--	No
Manganese	Yes	Yes	Yes	--	6	6	Yes	0.543	0.51	Yes	1.11452	Yes	Yes
Nitrate-Nitrite as N	No	Yes	No	--	6	6	--	--	--	--	--	--	No
Potassium	Yes	Yes	No	--	2	6	--	--	--	--	--	--	No
Sodium	Yes	No	--	--	6	6	--	--	--	--	--	--	No

**Notes:**

(1) See Section K.2.1 for evidence if answer is yes.

"--" = Not evaluated because chemical was determined not to be a COPC in a previous step or information is not necessary.

95% UCL = 95 percent upper confidence limit

COPC = chemical of potential concern

## **ATTACHMENT A2**

### **Cancer Classification and Toxicity Values for Human Health Risk Assessment**

**TABLE A2-1**  
**CANCER CLASSIFICATION FOR HUMAN HEALTH RISK ASSESSMENT**  
**ZONE B, OU8, LF5 RI, F.E. WARREN AFB**

Chemical of Potential Concern	Cancer Classification (1)	Source
Barium	D	IRIS
Calcium	--	--
Manganese	D	IRIS
Trichloroethene	C-B2 (2)	NCEA (3)

**Notes:**

IRIS was searched on November 18, 1999

(1) Cancer Classifications:

A-known human carcinogen

B2-probable Human Carcinogen

C-possible Human Carcinogen

D-not classifiable

(2) On the C-B2 continuum.

(3) EPA, 1992. Risk Assessment Issue Paper for: Carcinogenicity Information for Trichloroethylene (CASRN 79-01-6). Superfund Technical Support Center National Center for Environmental Assessment. March 5.

**TABLE A2-2**  
**TOXICITY VALUES FOR HUMAN HEALTH RISK ASSESSMENT**  
**ZONE B, OU8, LF5 RI, F.E. WARREN AFB**

Chemical of Potential Concern	Value	Source	Species	Endpoint
<b>Inhalation Slope Factor (SFi) (mg/kg-day)<sup>-1</sup></b>				
Barium	--	--	--	--
Calcium	--	--	--	--
Manganese	--	--	--	--
Trichloroethene	6.00E-03	NCEA (2)	Mouse	liver/kidney
<b>Oral Slope Factor (So)(1) (mg/kg-day)<sup>-1</sup></b>				
Barium	--	--	--	--
Calcium	--	--	--	--
Manganese	--	--	--	--
Trichloroethene	1.10E-02	NCEA (2)	Mouse	liver/kidney
<b>Chronic Non-Cancer Inhalation Reference Dose (RfD) (mg/kg-day)</b>				
Barium	1.43E-04	HEAST Alternate	Human	No adverse effects
Calcium	--	--	--	--
Manganese	1.43E-05	IRIS	Human	CNS effects
Trichloroethene	--	--	--	--
<b>Chronic Non-Cancer Oral Reference Dose (RfDo)(1) (mg/kg-day)</b>				
Barium	7.00E-02	IRIS	Human	No adverse effects
Calcium	1.40E+01	EPA Region VIII	--	--
Manganese	2.00E-02	IRIS (3)	Human	CNS effects
Trichloroethene	6.00E-03	NCEA(4)	Mouse	liver/kidney

**Notes:**

IRIS was searched on November 18, 1999

- (1) Adjusted oral slope factors and oral reference doses were also used to assess toxicity, hazard, and cancer risk for dermal exposure pathways for barium and manganese. Oral slope factors and oral reference doses for other COPCs were not adjusted for dermal hazard and risk calculations (EPA 1998a).
- (2) EPA, 1992. Risk Assessment Issue Paper for: Carcinogenicity Information for Trichloroethylene (CASRN 79-01-6). Superfund Technical Support Center National Center for Environmental Assessment. March 5.
- (3) The non-food RfDo was used.
- (4) EPA, 1992. Risk Assessment Issue Paper for: Provisional Oral RfD for Trichloroethylene (CASRN 79-01-6). Superfund Technical Support Center National Center for Environmental Assessment. March 5.

## **ATTACHMENT A3**

### **Summary of Health Risks**

**TABLE A3-1**  
**SUMMARY OF HEALTH RISKS**  
**CHILD / ADULT RECREATIONAL VISITORS**  
**ZONE B, OU8, LF5 RI, F.E. WARREN AFB**

Receptor/Pathways	Central Tendency		Reasonable Maximum Exposure	
	Hazard Index (Child/Adult)	Cancer Risk (Adult)	Hazard Index (Child/Adult)	Cancer Risk (Adult)
Child/Adult Recreational Visitor				
Surface Water Ingestion	4.22E-05	2.67E-12	4.84E-03	1.02E-09
Surface Water Dermal	4.76E-04	2.53E-11	9.18E-03	1.63E-09
<b>Total</b>	<b>5E-04</b>	<b>3E-11</b>	<b>1E-02</b>	<b>3E-09</b>

**TABLE A3-2**  
**SUMMARY OF HEALTH RISKS**  
**YOUTH RESIDENT**  
**ZONE B, OU8, LF5 RI, F.E. WARREN AFB**

Receptor/Pathway	Central Tendency		Reasonable Maximum Exposure	
	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Youth Resident				
Surface Water Ingestion	6.31E-04	2.22E-11	1.51E-02	1.06E-09
Surface Water Dermal	1.18E-02	3.48E-10	4.72E-02	2.78E-09
<b>Total</b>	<b>1E-02</b>	<b>4E-10</b>	<b>6E-02</b>	<b>4E-09</b>

**TABLE A3-3**  
**SUMMARY OF TOTAL HAZARD INDICES AND CANCER RISKS**  
**ZONE B, OU8, LF5 RI, F.E. WARREN AFB**

Receptor/Pathway	Central Tendency		Reasonable Maximum Exposure	
	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Child/Adult Recreational Visitor	5E-04	3E-11	1E-02	3E-09
Child/Adult Youth Resident	1E-02	4E-10	6E-02	4E-09

## **ATTACHMENT A4**

### **Summary of Ecological Chemicals of Potential Concern and Ecological Exposure Pathways of Concern**

**TABLE A4-1**  
**SUMMARY OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN**  
**ZONE B, OU8, LF5 RI, F.E. WARREN AFB**

Detected Chemical	Exposure Media and COPCs					
	Surface Soil <sup>1</sup> (Areas 1-8)	Subsurface Soil <sup>2</sup> (LF-5a Outside Perimeter)	Subsurface Soil <sup>2</sup> (LF-5b Outside Perimeter)	Subsurface Soil <sup>2</sup> (LF-5b Inside Perimeter)	Unnamed Tributary Sediment <sup>3</sup>	Unnamed Tributary Surface Water <sup>4</sup>
<b>Volatiles</b>						
Benzene					X	
Chloroethane						X
Methylene chloride						X
Toluene					X	
Trichloroethene					X	
Trichlorofluoromethane					X	
cis-1,2-Dichloroethene					X	
<b>Semi-volatiles</b>						
bis(2-Ethylhexyl)phthalate		X			X	
<b>Pesticides/PCBs</b>						
4,4'-DDD					X	
4,4'-DDE					X	
4,4'-DDT				X	X	
Dieldrin					X	
Endosulfan Sulfate					X	
Heptachlor					X	
PCB-1248				X		
alpha-BHC					X	
<b>Inorganics</b>						
Antimony				X		
Arsenic	X					
Barium			X			X
Boron				X		
Cadmium				X		
Chromium (total)	X					
Hydrogen sulfide				X		
Lead	X					
Mercury				X		
Zinc				X		

**Notes:**

X - Ecological Chemical of Potential Concern  
COPC = Chemical of Potential Concern

- 1- See Table K.3-4 for selection of COPCs in surface soil
- 2- See Tables K.3-5 through K.3-7 for selection of COPCs in subsurface soil
- 3- See Table K.3-8 for selection of COPCs in sediment
- 4- See Table K.3-9 for selection of COPCs in surface water

**TABLE A4-2**  
**ECOLOGICAL EXPOSURE PATHWAYS OF CONCERN**  
**Zone B: OU8, LF5, F.E. Warren AFB**

Exposure Medium	Sensitive Environmen	Receptor	T&E Species	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Surface Water in intermittent Unnamed Tributary	N	Fish and aquatic biota	N	Direct contact; direct and indirect (via food web) ingestion of chemicals in surface water	Maintenance of fish and aquatic biota populations	Surface water toxicity determined by comparing surface water chemical concentrations to site reference concentrations and ambient water quality criteria representing protection of 95 percent of aquatic genera from adverse effects on growth, reproduction, and mortality.
Sediment in Unnamed Tributary	N	Benthic macro-invertebrates and aquatic biota	N	Direct contact; direct and indirect (via food web) ingestion of chemicals in sediment	Maintenance of benthic invertebrate and aquatic biota populations	Sediment toxicity determined by comparing sediment chemical concentrations to reference site concentrations and sediment quality values protective of aquatic organisms from adverse effects on growth, reproduction, and survival.
Surface Soil in eight exposure areas	N	Terrestrial plants, soil invertebrates	N	Direct contact of chemicals in surface soil	Maintenance of local shortgrass prairie plant and soil invertebrate populations	Surface soil toxicity determined by comparing soil chemical concentrations to background concentrations and soil quality values protective of plants and soil-dwelling invertebrates.
		Terrestrial birds and small mammals	N <sup>(1)</sup>	Direct and indirect (via food web) ingestion of chemicals in surface soil	Maintenance of local bird and small mammal populations using the shortgrass prairie	Surface soil toxicity determined by comparing estimated daily doses of site-related chemicals in soil to toxicity reference values (representing no adverse effects levels for individual reproduction and survival) for the deer mouse, horned lark, and western meadowlark.
Subsurface Soil in LF5a and LF5b (outside perimeter) and LF5a (inside perimeter trench)	N	Terrestrial plants	N	Direct contact of chemicals in subsurface soil	Maintenance of local plant populations	Subsurface soil toxicity determined by comparing soil chemical concentrations to background concentrations and soil quality values protective of plants.

- (1) The threatened Preble's meadow jumping mouse (*Zapus hudsonium preblei*) is not considered a receptor for the short grass prairie habitat; its range is restricted to the riparian zone bordering Crow and Diamond Creeks.
- (2) Maintenance of the local population includes protection of the local communities and their natural species diversity and abundance.

## **ATTACHMENT A5**

### **Summary of Detailed Analysis of Remedial Alternatives**

**TABLE A5-1**  
**SUMMARY OF DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES**  
**Zone B: OU8, LF5 Feasibility Study**

Remedial Alternatives	Overall Protection of Human Health and Environment	Compliance with Potential ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-Term Effectiveness	Implementability	Cost
ALTERNATIVE 1—No Action	Does not protect human health and the environment.	Does not comply with all potential chemical-, action-, and location-specific ARARs.	Does not provide long-term effectiveness because untreated TCE contamination remains in groundwater at concentrations exceeding the MCL. However, concentrations are relatively low and may be reduced over time but there are no management controls to prevent exposure to groundwater or to monitor the residual concentrations in groundwater.	Toxicity, mobility and volume of TCE are not reduced by active treatment.	No additional risk to site workers and the environment because there is no construction.	Very easy to implement. No monitoring of the effectiveness is possible.	\$ 0.00
ALTERNATIVE 2—Institutional Controls	Does not protect human health and the environment. No unacceptable short-term or cross media impacts are expected.	Complies with all potential action- and location-specific ARARs. Would not comply with potential chemical-specific ARARs, because there is no means of monitoring plume attenuation. No discharge permits are needed for this alternative.	Although untreated TCE contamination remains in groundwater at concentrations exceeding the MCL, provides long term effectiveness by implementing institutional controls to limit or prevent use of groundwater and managing risk posed by the remaining TCE. Controls contained in the General Plan are a long term and reliable management control to provide protection because they are required for all major installations and are enforceable by the Installation Commander. Does not provide for monitoring the residual concentrations in groundwater to MCLs over time. Minimal administrative activities and periodic monitoring are required.	Toxicity, mobility and volume of TCE are not reduced by active treatment.	No additional risk to site workers and the environment because there is no construction. No increased risk to workers, the community, or the environment during implementation. Time to enact institutional controls and achieve protection is estimated to be 1 year.	Very easy to implement technically and administratively. FEW administrative requirements include modifying the General Plan. Reliable management control that includes administrative monitoring and review on an annual basis. Minimal coordination activities with EPA and WDEQ. No groundwater monitoring proposed to monitor effectiveness.	Capital \$20,467  Total O&M \$29,029  Present Worth \$35,623
ALTERNATIVE 3—Natural Attenuation/Long-Term Monitoring	Protects human health and the environment under current conditions through natural attenuation processes. No unacceptable short-term or cross media impacts are expected.	Complies with all potential chemical-, action-, and location-specific ARARs. Any soil spoils generated from installation of the wells will remain onsite in accordance with potential ARARs. No discharge permits are needed for this alternative.	Natural processes will reduce contaminant levels in groundwater to MCLs over time. Continued monitoring provides a reliable means to assess the residual concentrations and manage the risk posed by the residual. Institutional controls would limit or prevent use of groundwater. No untreated residual contamination would be produced by this treatment process. Minimal operation and maintenance of wells and groundwater sampling are required.	Toxicity, mobility and volume of TCE are reduced over time from natural attenuation of contaminants in groundwater. TCE levels are reduced to MCLs. No treatment residuals present in groundwater at completion. Treatment is irreversible.	Minimal additional risk to site workers and the environment during installation of wells. Excavated material will remain onsite, therefore the community does not incur incremental risk associated with traffic and offsite disposal. No increased risk to workers, the community, or the environment during implementation. Time to achieve MCLs within Zone B is estimated to be approximately 50 years.	Easy to implement. Equipment is standard and readily available. Conventional well installation techniques would be used and would be easy to construct. Should not create schedule delays. Passive treatment that does not require removal, aboveground treatment or TSD services. Monitoring the effectiveness is simple. Competitive bids can be obtained. FEW administrative requirements include modifying the General Plan.	Capital \$183,381  Total O&M \$3,274,341  Present Worth \$1,552,966
ALTERNATIVE 4—In Situ Permeable Reactive Barrier	Protects human health and the environment under current conditions through in situ treatment. No unacceptable short-term or cross media impacts are expected.	Complies with all potential chemical-, action-, and location-specific ARARs. Any soil spoils generated from installation of the treatment wall will remain onsite in accordance with potential ARARs. No discharge permits are needed for this alternative.	In situ treatment will reduce contaminant levels in groundwater to MCLs. Continued monitoring provides a reliable means to assess the treatment effectiveness. Institutional controls would limit or prevent use of groundwater. No untreated residual contamination would be produced by this treatment process. Minimal operation and maintenance of the PRB over 25 years, however, it may require periodic cleaning or replacement.	Toxicity, mobility and volume of TCE are reduced over time from in situ treatment of groundwater. TCE levels are reduced to MCLs. Treatment residuals (degradation products of TCE) present in groundwater located downgradient of wall at nontoxic or below MCL concentrations. Treatment is irreversible.	Minimal additional risk to site workers and the environment during construction. Excavated material will remain onsite, therefore the community does not incur incremental risk associated with traffic and offsite disposal. No increased risk to workers, the community, or the environment during implementation. Time to achieve MCLs is estimated to be approximately 25 years.	Moderately difficult to implement. Innovative technology. Predesign investigations would be required prior to full scale design. Technology is patented and licensed. Laboratory bench scale column tests would be required. Equipment and materials are available. Conventional construction techniques would be used and should not create schedule delays. Monitoring the effectiveness is simple. Competitive bids for installation can be obtained. FEW administrative requirements include modifying the General Plan. Would require consultation with other agencies regarding construction near sensitive species habitat.	Capital \$1,023,174  Total O&M \$1,248,163  Present Worth \$2,008,097
ALTERNATIVE 5—Groundwater Extraction and Treatment	Protects human health and the environment under current conditions through removal and treatment of the contaminated groundwater. No unacceptable short-term or cross media impacts are expected.	Complies with all potential chemical-, action-, and location-specific ARARs. Any soil spoils generated from installation of the wells will remain onsite in accordance with potential ARARs. Compliance with the substantive requirements of an NPDES discharge permit is needed for this alternative.	Ex situ treatment will reduce contaminant levels in groundwater. Continued monitoring provides a reliable means to assess the treatment effectiveness. Institutional controls would limit or prevent use of groundwater. Activated carbon would contain the TCE, however, it would be shipped offsite for destruction through regeneration. Greater operation and maintenance only during 7-year treatment period.	Toxicity, mobility and volume of TCE are reduced over time from ex situ treatment of groundwater. TCE adsorbed to activated carbon. TCE levels in groundwater reduced to MCLs. Treatment is irreversible.	Minimal additional risk to site workers and the environment during construction. Excavated material will remain onsite, therefore the community does not incur incremental risk associated with traffic and offsite disposal. No increased risk to workers, the community, or the environment during implementation. Transport of spent carbon vessel to offsite regeneration facility would pose minimal risk to community. Time to achieve MCLs is estimated to be approximately 7 years.	Moderately easy to implement. Carbon adsorption is a proven and reliable technology. Equipment (carbon vessels, pumps) and carbon regeneration services are readily available. Conventional construction techniques would be used and should be easy to construct and not create schedule delays. Monitoring the effectiveness is simple. Multiple suppliers of carbon equipment are available. Competitive bids can be obtained. Administrative requirements include compliance with the substantive requirements of an NPDES permit and modifying the General Plan.	Capital \$439,222  Total O&M \$1,489,502  Present Worth \$1,729,257

Notes:  
ARARs = Applicable or relevant and appropriate requirements  
FEW = F.E. Warren Air Force Base  
MCLs = Maximum contaminant levels  
NPDES = National Pollution Discharge Elimination System  
RCRA = Resource Conservation Recovery Act  
TCE = Trichloroethene  
USC = U.S. Code

**ATTACHMENT A6**

**Proposed Performance Monitoring  
Analytical List  
and  
WCA Detection Monitoring Constituents**

**TABLE A6-1  
PROPOSED PERFORMANCE MONITORING ANALYTICAL LIST**

Analysis	Analytical Method	Field Instrument or Laboratory Analysis	Treatment Goal (µg/L)
Water-level/surface water stage	Electric Tape/flume	Field	NA
pH	SW9040B	Field	NA
Water temperature	E170.1	Field	NA
Redox potential (Eh)	ASTM D1498	Field	NA
Dissolved oxygen	Flow-through Cell	Field	NA
Specific conductance	SW9050	Field	NA
Turbidity (groundwater only)	E180.1	Field	NA
Total dissolved solids (TDS)	E160.2	Lab	NA
Total suspended solids (TSS)	E160.1	Lab	NA
Total organic carbon (TOC)	SW9060	Lab	NA
Dissolved organic carbon (DOC)	SW9060	Lab	NA
Alkalinity	E310.1	Lab	NA
Potassium	SW6010B	Lab	NA
Sodium	SW6010B	Lab	NA
Calcium	SW6010B	Lab	NA
Magnesium	SW6010B	Lab	NA
Iron (total)	SW6010B	Lab	NA
Manganese	SW6010B	Lab	NA
Sulfate	SW9056	Lab	NA
Nitrate	SW9056	Lab	NA
Chloride	SW9056	Lab	NA
Trichloroethene	SW8260	Lab	5
Total 1,2-DCE	SW8260	Lab	300
7DCE	SW8260	Lab	100
CDCE	SW8260	Lab	70
Vinyl Chloride	SW8260	Lab	2

**Notes:**

Analytical list presented for FS scoping and cost-estimating purposes.

ASTM = American Society for Testing and Materials

DCE = Dichloroethene

cDCE = *cis*-1,2-dichloroethene

tDCE = *trans*-1,2-dichloroethene

µg/L = Micrograms per liter

NA = Not applicable

**TABLE A6-2**  
**WCA DETECTION MONITORING CONSTITUENTS**

<b>Inorganic Constituents</b>
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium
Cobalt
Copper
Lead
Nickel
Selenium
Silver
Thallium
Vanadium
Zinc
<b>Organic Constituents</b>
Acetone
Acrylonitrile
Benzene
Bromochloromethane
Bromodichloromethane
Bromoform, Tribromomethane
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane; Ethyl chloride
Chloroform; Trichloromethane
Dibromochloromethane; Chlorodibromomethane
1,2-Dibromo-3-chloropropane; DBCP
1,2-Dibromoethane; Ethylene dibromide; EDB
o-Dichlorobenzene; 1,2-Dichlorobenzene
p-Dichlorobenzene; 1,4-Dichlorobenzene
Trans-1,4-Dichloro-2-butene
1,1-Dichloroethane; Ethylidene chloride
1,2-Dichloroethane; Ethylene dichloride
1,1-Dichloroethylene; 1,1-Dichloroethane; Vinylidene chloride

**TABLE A6-2**  
**WCA DETECTION MONITORING CONSTITUENTS**

cis-1,2-Dichloroethylene; cis-1,2-Dichloroethene
trans-1,2-Dichloroethylene; trans-1,2-Dichloroethene
1,2-Dichloropropane; Propylene dichloride
cis-1,3-Dichloropropene
Trans-1,3-Dichloropropene
Ethylbenzene
2-Hexanone; Methyl butyl ketone
Methyl bromide; Bromomethane
Methyl chloride; Chloromethane
Methylene bromide; Dibromomethane
Methylene chloride; Dichloromethane
Methyl ethyl ketone; MEK; 2-Butanone
Methyl iodide; Iodomethane
4-Methyl-2-pentanone; Methyl isobutyl ketone
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethylene; Tetrachloroethane; Perchloroethylene
Toluene
1,1,1-Trichloroethane; Methylchloroform
1,1,2-Trichloroethane
Trichloroethylene, Trichloroethene
Trichlorofluoromethane; CFC-11
1,2,3-Trichloropropane
Vinyl acetate
Vinyl chloride
Xylenes

## **ATTACHMENT A7**

### **Detailed Cost Summary Tables for Selected Remedy**

# Detailed Cost Summary Tables for Groundwater Remedy

Alternative  
Name: Extraction & Treatment

# CAPITAL COST SUMMARY

Site: Zone B  
Location: F.E. Warren AFB, Wyoming  
Phase: Feasibility Study  
Base Year: 2000  
Date: 18-Oct-00

Description:

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
DESIGN & ENGINEERING					
GROUNDWATER EXTRACTION & TREATMENT	1.00	LS	\$ 126,796.00	\$ 126,796	
TREATMENT BUILDING - FACILITY	1.00	LS	\$ 14,615.00	\$ 14,615	
GROUNDWATER EXTRACTION & TREATMENT					
GROUNDWATER EXTRACTION WELLS	4.00	EA	\$ 13,544.00	\$ 54,176	
PROFESSIONAL LABOR MANAGEMENT	1.00	LS	\$ 80,882.00	\$ 80,882	
CARBON ADSORPTION (LIQUID)	25.00	GPM	\$ 523.48	\$ 13,087	
TRENCHING & PIPING	600.00	LF	\$ 28.54	\$ 17,123	
DEMOLITION, PAVEMENTS	4.32	CY	\$ 67.59	\$ 292	
RESURFACING ROADWAYS/PARKING	10.67	SY	\$ 13.87	\$ 148	
GROUNDWATER MONITORING WELL	1.00	EA	\$ 8,597.00	\$ 8,597	
TREATMENT BUILDING - FACILITY					
PARKING LOTS	633.33	SY	\$ 40.25	\$ 25,490	
OVERHEAD ELECTRICAL DISTRIBUTION	300.00	LF	\$ 54.70	\$ 16,411	
FENCING	350.00	LF	\$ 45.53	\$ 15,937	
USER DEFINED ESTIMATE (BUILDING)	400.00	SF	\$ 98.98	\$ 39,593	
PROFESSIONAL LABOR MANAGEMENT	1.00	LS	\$ 26,075.00	\$ 26,075	
<b>TOTAL CAPITAL COST</b>				<b>\$ 439,222</b>	

Alternative: 5  
 Name: Extraction & Treatment  
 Site: Zone B  
 Location: F.E. Warren AFB, Wyoming  
 Phase: Feasibility Study  
 Base Year: 2000  
 Date: 18-Oct-00

## TOTAL O&M COST SUMMARY

Description:

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	1.00	YR	\$ 29,060.00	\$ 29,060	
GROUNDWATER EXTRACTION WELLS	1.00	YR	\$ 11,146.00	\$ 11,146	
CARBON ADSORPTION (LIQUID)	1.00	YR	\$ 25,219.00	\$ 25,219	
MONITORING					
GROUNDWATER	1.00	YR	\$ 47,908.00	\$ 47,908	
GENERAL MONITORING	1.00	YR	\$ 86,518.00	\$ 86,518	
<b>SUBTOTAL YEAR 0</b>	<b>1.00</b>	<b>YR</b>	<b>\$ 199,851.00</b>	<b>\$ 199,851</b>	
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	1.00	YR	\$ 48,709.00	\$ 48,709	
GROUNDWATER EXTRACTION WELLS	1.00	YR	\$ 22,293.00	\$ 22,293	
CARBON ADSORPTION (LIQUID)	1.00	YR	\$ 50,438.00	\$ 50,438	
MONITORING					
GROUNDWATER	1.00	YR	\$ 59,885.00	\$ 59,885	
GENERAL MONITORING	1.00	YR	\$ 108,148.00	\$ 108,148	
<b>SUBTOTAL YEAR 1</b>	<b>1.00</b>	<b>YR</b>	<b>\$ 289,473.00</b>	<b>\$ 289,473</b>	
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	4.00	YR	\$ 41,689.00	\$ 166,756	
GROUNDWATER EXTRACTION WELLS	4.00	YR	\$ 22,293.00	\$ 89,172	

Alternative 5

Name: Extraction &amp; Treatment

Site: Zone B

Location: F.E. Warren AFB, Wyoming

Phase: Feasibility Study

Base Year: 2000

Date: 18-Oct-00

Description:

## TOTAL O&amp;M COST SUMMARY

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
CARBON ADSORPTION (LIQUID)	4.00	YR	\$ 50,438.00	\$ 201,752	
MONITORING					
GROUNDWATER	4.00	YR	\$ 23,954.00	\$ 95,816	
GENERAL MONITORING	4.00	YR	\$ 43,259.00	\$ 173,036	
<b>SUBTOTAL YEAR 2-4 &amp; 6</b>	<b>4.00</b>	<b>YR</b>	<b>\$ 181,633.00</b>	<b>\$ 726,532</b>	
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	1.00	YR	\$ 44,081.00	\$ 44,081	
GROUNDWATER EXTRACTION WELLS	1.00	YR	\$ 22,293.00	\$ 22,293	
CARBON ADSORPTION (LIQUID)	1.00	YR	\$ 50,438.00	\$ 50,438	
MONITORING			\$ 116,812.00		
GROUNDWATER	1.00	YR	\$ 23,954.00	\$ 23,954	
GENERAL MONITORING	1.00	YR	\$ 43,259.00	\$ 43,259	
<b>SUBTOTAL YEAR 5</b>	<b>1.00</b>	<b>YR</b>	<b>\$ 184,025.00</b>	<b>\$ 184,025</b>	
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	1.00	YR	\$ 19,649.00	\$ 19,649	
GROUNDWATER EXTRACTION WELLS	1.00	YR	\$ 11,146.00	\$ 11,146	
CARBON ADSORPTION (LIQUID)	1.00	YR	\$ 25,219.00	\$ 25,219	
MONITORING					

### TOTAL O&M COST SUMMARY

**Description:**

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
GROUNDWATER	1.00	YR	\$ 11,977.00	\$ 11,977	
GENERAL MONITORING	1.00	YR	\$ 21,630.00	\$ 21,630	
SUBTOTAL YEAR 7	1.00	YR	\$ 89,621.00	\$ 89,621	
<b>TOTAL ANNUAL O&amp;M COST</b>				<b>\$ 1,489,502</b>	

Alternative:  
Name: Extraction & Treatment

# TOTAL PRESENT VALUE ANALYSIS

Site: Zone B  
Location: F.E. Warren AFB, Wyoming  
Phase: Feasibility Study  
Base Year: 2000  
Date: 18-Oct-00  
Discount: 5.00%

Description:

YEAR	DESCRIPTION	CAPITAL COST	ANNUAL O&M COST	PERIODIC COST	TOTAL COST	DISCOUNT FACTOR	PRESENT VALUE
0	GW EXTRACTION & TREATMENT AND O&M&M	\$ 439,222	\$ 199,851		\$ 639,073	1.0000	\$ 639,073
1	OPERATION & MAINTENANCE AND MONITORING		\$ 289,473		\$ 289,473	0.9524	\$ 275,689
2	OPERATION & MAINTENANCE AND MONITORING		\$ 181,633		\$ 181,633	0.9070	\$ 164,746
3	OPERATION & MAINTENANCE AND MONITORING		\$ 181,633		\$ 181,633	0.8638	\$ 156,901
4	OPERATION & MAINTENANCE AND MONITORING		\$ 181,633		\$ 181,633	0.8227	\$ 149,430
5	OPERATION & MAINTENANCE AND MONITORING		\$ 184,025		\$ 184,025	0.7835	\$ 144,188
6	OPERATION & MAINTENANCE AND MONITORING		\$ 181,633		\$ 181,633	0.7462	\$ 135,537
7	OPERATION & MAINTENANCE AND MONITORING		\$ 89,621		\$ 89,621	0.7107	\$ 63,692
TOTALS		\$ 439,222	\$ 1,489,502	\$ -	\$ 1,928,724		\$ 1,729,257

Alternative: 5  
Name: Extraction & Treatment

# PRESENT VALUE ANALYSIS

Site: Zone B  
Location: F.E. Warren AFB, Wyoming  
Phase: Feasibility Study  
Base Year: 2000  
Date: 18-Oct-00  
Discount: 5.00%

Description:

YEAR	DESCRIPTION	CAPITAL COST	ANNUAL O&M COST	PERIODIC COST	TOTAL COST	DISCOUNT FACTOR	PRESENT VALUE
	<b>CAPITAL COST</b>						
0	GROUNDWATER EXTRACTION & TREATMENT	\$ 439,222			\$ 439,222	1.0000	\$ 439,222
	<b>TOTAL CAPITAL COST</b>				\$ 439,222		\$ 439,222
	<b>OPERATION &amp; MAINTENANCE COST</b>						
0	OPERATION & MAINTENANCE AND MONITORING		\$ 199,851		\$ 199,851	1.0000	\$ 199,851
1	OPERATION & MAINTENANCE AND MONITORING		\$ 289,473		\$ 289,473	0.9524	\$ 275,689
2	OPERATION & MAINTENANCE AND MONITORING		\$ 181,633		\$ 181,633	0.9070	\$ 164,746
3	OPERATION & MAINTENANCE AND MONITORING		\$ 181,633		\$ 181,633	0.8638	\$ 156,901
4	OPERATION & MAINTENANCE AND MONITORING		\$ 181,633		\$ 181,633	0.8227	\$ 149,430
5	OPERATION & MAINTENANCE AND MONITORING		\$ 184,025		\$ 184,025	0.7835	\$ 144,188
6	OPERATION & MAINTENANCE AND MONITORING		\$ 181,633		\$ 181,633	0.7462	\$ 135,537
7	OPERATION & MAINTENANCE AND MONITORING		\$ 89,621		\$ 89,621	0.7107	\$ 63,692
	<b>TOTAL OPERATION &amp; MAINTENANCE COST</b>				\$ 1,489,502		\$ 1,290,035
	<b>PERIODIC COST</b>						
0	NONE				\$ -	1.0000	\$ -
	<b>TOTAL PERIODIC COST</b>				\$ -		\$ -
<b>TOTALS</b>		\$ 439,222	\$ 1,489,502	\$ -	\$ 1,928,724		\$ 1,729,257

## Detailed Cost Summary Tables for WCA Remedy

Name: Waste Co-location Area O&M and LTM

Site: Zone B  
Location: F.E. Warren AFB, Wyoming  
Phase: Feasibility Study  
Base Year: 2000  
Date: 18-Oct-00

**Description:** THIS WORKSHEET IS PROVIDED FOR INFORMATIONAL PURPOSES ONLY. Remedial Design and Capital costs provided below are not included in the "Comparision of Total Cost for Remedial Alternatives" and are developed for the purposes of calculating necessary cost parameters for Landfill 5a Operation & Maintenance.

## CAPITAL COST SUMMARY

[illegible]

Alternative: 0  
 Name: Waste Co-location Area O&M and LTM  
 Site: Zone B  
 Location: F.E. Warren AFB, Wyoming  
 Phase: Feasibility Study  
 Base Year: 2000  
 Date: 18-Oct-00

# TOTAL O&M COST SUMMARY

Description:

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	1.00	YR	\$ 16,586.00	\$ 16,586	
CAPPING	1.00	YR	\$ 46,824.00	\$ 46,824	
LONG-TERM MONITORING					
MONITORING	1.00	YR	\$ 95,278.00	\$ 95,278	
<b>SUBTOTAL O&amp;M YEAR 1</b>	<b>1.00</b>	<b>YR</b>	<b>\$ 158,688.00</b>	<b>\$ 158,688</b>	
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	1.00	YR	\$ 49,691.00	\$ 49,691	
CAPPING	1.00	YR	\$ 93,648.00	\$ 93,648	
LONG-TERM MONITORING					
MONITORING	1.00	YR	\$ 119,097.00	\$ 119,097	
<b>SUBTOTAL O&amp;M YEAR 2</b>	<b>1.00</b>	<b>YR</b>	<b>\$ 262,436.00</b>	<b>\$ 262,436</b>	
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	20.00	YR	\$ 115,768.00	\$ 2,315,360	
CAPPING	20.00	YR	\$ 93,648.00	\$ 1,872,960	
LONG-TERM MONITORING					
MONITORING	20.00	YR	\$ 47,639.00	\$ 952,780	
<b>SUBTOTAL O&amp;M YEAR 3-5, 7-9, 12-15, 17-19, 22-25 &amp; 27-29</b>	<b>20.00</b>	<b>YR</b>	<b>\$ 257,055.00</b>	<b>\$ 5,141,100</b>	

Alternative:

Name: Waste Co-location Area O&amp;M and LTM

Site: Zone B

Location: F.E. Warren AFB, Wyoming

Phase: Feasibility Study

Base Year: 2000

Date: 18-Oct-00

Description:

**TOTAL O&M COST SUMMARY**

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	3.00	YR	\$ 165,325.00	\$ 495,975	
CAPPING	3.00	YR	\$ 93,648.00	\$ 280,944	
LONG-TERM MONITORING					
MONITORING	3.00	YR	\$ 47,639.00	\$ 142,917	
SUBTOTAL O&M YEAR 6, 16 & 26	3.00	YR	\$ 306,612.00	\$ 919,836	
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	3.00	YR	\$ 198,364.00	\$ 595,092	
CAPPING	3.00	YR	\$ 93,648.00	\$ 280,944	
LONG-TERM MONITORING					
MONITORING	3.00	YR	\$ 47,639.00	\$ 142,917	
SUBTOTAL O&M YEAR 10, 20 & 30	3.00	YR	\$ 339,651.00	\$ 1,018,953	
REMEDIAL ACTION (O&M)					
TREATMENT TRAIN MISCELLANEOUS	2.00	YR	\$ 247,921.00	\$ 495,842	
CAPPING	2.00	YR	\$ 93,648.00	\$ 187,296	
LONG-TERM MONITORING					
MONITORING	2.00	YR	\$ 47,639.00	\$ 95,278	
SUBTOTAL O&M YEAR 11 & 21	2.00	YR	\$ 389,208.00	\$ 778,416	

### TOTAL O&M COST SUMMARY

Site: Zone B  
Location: F.E. Warren AFB, Wyoming  
Phase: Feasibility Study  
Base Year: 2000  
Date: 18-Oct-00

[illegible]

Name: Waste Co-location Area O&M and LTM

Site: Zone B

Location: F.E. Warren AFB, Wyoming

Phase: Feasibility Study

**Base Year: 2000**

Date: 18-Oct-00

**Description:**

### TOTAL PERIODIC COST SUMMARY

[illegible]

Alternative: 0  
 Name: Waste Co-location Area O&M and LTM  
 Site: Zone B  
 Location: F.E. Warren AFB, Wyoming  
 Phase: Feasibility Study  
 Base Year: 2000  
 Date: 18-Oct-00  
 Discount: 5.00%

# TOTAL PRESENT VALUE ANALYSIS

Description:

YEAR	DESCRIPTION	CAPITAL COST	ANNUAL O&M COST	PERIODIC COST	TOTAL COST	DISCOUNT FACTOR	PRESENT VALUE
0	MONITORING PLAN	\$ -		\$ 136,272	\$ 136,272	1.0000	\$ 136,272
1	REMEDIAL ACTION (O&M AND LTM)		\$ 158,688		\$ 158,688	0.9524	\$ 151,131
2	REMEDIAL ACTION (O&M AND LTM)		\$ 262,436		\$ 262,436	0.9070	\$ 238,037
3	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.8638	\$ 222,054
4	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.8227	\$ 211,480
5	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.7835	\$ 201,409
6	REMEDIAL ACTION (O&M AND LTM)		\$ 306,612		\$ 306,612	0.7462	\$ 228,799
7	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.7107	\$ 182,684
8	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.6768	\$ 173,985
9	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.6446	\$ 165,700
10	REMEDIAL ACTION (O&M AND LTM)		\$ 339,651		\$ 339,651	0.6139	\$ 208,516
11	REMEDIAL ACTION (O&M AND LTM)		\$ 389,208		\$ 389,208	0.5847	\$ 227,562
12	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.5568	\$ 143,138
13	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.5303	\$ 136,322
14	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.5051	\$ 129,830
15	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.4810	\$ 123,648
16	REMEDIAL ACTION (O&M AND LTM)		\$ 306,612		\$ 306,612	0.4581	\$ 140,462
17	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.4363	\$ 112,152
18	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.4155	\$ 106,812
19	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.3957	\$ 101,725
20	REMEDIAL ACTION (O&M AND LTM)		\$ 339,651		\$ 339,651	0.3769	\$ 128,011

Name: Waste Co-location Area O&M and LTM

Site: Zone B

Location: F.E. Warren AFB, Wyoming

Phase: Feasibility Study

**Base Year: 2000**

Date: 18-Oct-00

Discount: 5.00%

**Description:**

### TOTAL PRESENT VALUE ANALYSIS

YEAR	DESCRIPTION	CAPITAL COST	ANNUAL O&M COST	PERIODIC COST	TOTAL COST	DISCOUNT FACTOR	PRESENT VALUE
21	REMEDIAL ACTION (O&M AND LTM)		\$ 389,208		\$ 389,208	0.3589	\$ 139,703
22	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.3418	\$ 87,874
23	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.3256	\$ 83,690
24	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.3101	\$ 79,705
25	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.2953	\$ 75,909
26	REMEDIAL ACTION (O&M AND LTM)		\$ 306,612		\$ 306,612	0.2812	\$ 86,232
27	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.2678	\$ 68,852
28	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.2551	\$ 65,573
29	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.2429	\$ 62,451
30	REMEDIAL ACTION (O&M AND LTM)		\$ 339,651		\$ 339,651	0.2314	\$ 78,588
31	REMEDIAL ACTION (O&M AND LTM)		\$ 235,968		\$ 235,968	0.2204	\$ 51,998
TOTALS		\$ -	\$ 8,515,397	\$ 136,272	\$ 8,651,669		\$ 4,350,303

Alternative: 0  
 Name: Waste Co-location Area O&M and LTM  
 Site: Zone B  
 Location: F.E. Warren AFB, Wyoming  
 Phase: Feasibility Study  
 Base Year: 2000  
 Date: 18-Oct-00  
 Discount: 5.00%

# TOTAL PRESENT VALUE ANALYSIS

Description:

YEAR	DESCRIPTION	CAPITAL COST	ANNUAL O&M COST	PERIODIC COST	TOTAL COST	DISCOUNT FACTOR	PRESENT VALUE
<b>CAPITAL COSTS</b>							
0	NOT INCLUDED IN THIS FEASIBILITY STUDY	\$			\$ -	1.0000	\$ -
	<b>TOTAL CAPITAL COST</b>				\$ -		\$ -
<b>OPERATION &amp; MAINTENANCE COST</b>							
1	REMEDIAL ACTION (O&M AND LTM)		\$ 158,688		\$ 158,688	0.9524	\$ 151,131
2	REMEDIAL ACTION (O&M AND LTM)		\$ 282,436		\$ 282,436	0.9070	\$ 238,037
3	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.8638	\$ 222,054
4	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.8227	\$ 211,480
5	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.7835	\$ 201,409
6	REMEDIAL ACTION (O&M AND LTM)		\$ 306,612		\$ 306,612	0.7462	\$ 228,799
7	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.7107	\$ 182,684
8	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.6768	\$ 173,985
9	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.6446	\$ 165,700
10	REMEDIAL ACTION (O&M AND LTM)		\$ 339,651		\$ 339,651	0.6139	\$ 208,516
11	REMEDIAL ACTION (O&M AND LTM)		\$ 389,208		\$ 389,208	0.5847	\$ 227,562
12	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.5568	\$ 143,138
13	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.5303	\$ 136,322
14	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.5051	\$ 129,830
15	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.4810	\$ 123,648
16	REMEDIAL ACTION (O&M AND LTM)		\$ 306,612		\$ 306,612	0.4581	\$ 140,462

Alternative:

Name: Waste Co-location Area O&amp;M and LTM

**TOTAL PRESENT VALUE ANALYSIS**

Site: Zone B

Description:

Location: F.E. Warren AFB, Wyoming

Phase: Feasibility Study

Base Year: 2000

Date: 18-Oct-00

Discount: 5.00%

YEAR	DESCRIPTION	CAPITAL COST	ANNUAL O&M COST	PERIODIC COST	TOTAL COST	DISCOUNT FACTOR	PRESENT VALUE
17	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.4363	\$ 112,152
18	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.4155	\$ 106,812
19	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.3957	\$ 101,725
20	REMEDIAL ACTION (O&M AND LTM)		\$ 339,651		\$ 339,651	0.3769	\$ 128,011
21	REMEDIAL ACTION (O&M AND LTM)		\$ 389,208		\$ 389,208	0.3589	\$ 139,703
22	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.3418	\$ 87,874
23	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.3256	\$ 83,690
24	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.3101	\$ 79,705
25	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.2953	\$ 75,909
26	REMEDIAL ACTION (O&M AND LTM)		\$ 306,612		\$ 306,612	0.2812	\$ 86,232
27	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.2678	\$ 68,852
28	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.2551	\$ 65,573
29	REMEDIAL ACTION (O&M AND LTM)		\$ 257,055		\$ 257,055	0.2429	\$ 62,451
30	REMEDIAL ACTION (O&M AND LTM)		\$ 339,651		\$ 339,651	0.2314	\$ 78,588
31	REMEDIAL ACTION (O&M AND LTM)		\$ 235,968		\$ 235,968	0.2204	\$ 51,998
	TOTAL OPERATION & MAINTENANCE COST				\$ 8,515,397		\$ 4,214,031
	PERIODIC COST						
0	MONITORING PLAN			\$ 136,272	\$ 136,272	1.0000	\$ 136,272
	TOTAL PERIODIC COST				\$ 136,272		\$ 136,272
TOTALS		\$ -	\$ 8,515,397	\$ 136,272	\$ 8,651,669		\$ 4,350,303

**ATTACHMENT A8**

**Chemical, Action, and Location  
Specific ARARs**

**Chemical, Action, and Location Specific ARARS  
for Groundwater**

**TABLE A8-1  
CHEMICAL-SPECIFIC ARARs  
Zone B**

Standard, Requirement, Criteria, or Limitation	Citations	Description	Applicable/Relevant and Appropriate	Comments
<b>FEDERAL</b>				
<b>SAFE DRINKING WATER ACT</b>	42 USC Sec. 300G	--	--	--
National Primary Drinking Water Regulations	40 CFR 141, Subparts B and G	Establishes health-based standards for public drinking water systems (MCLs)	No/Yes	Groundwater is a potential source of drinking water. MCLs are relevant and appropriate.
Maximum Contaminant Level Goals (MCLGs)	40 CFR 141, Subpart F	Establishes non-enforceable drinking water quality goals set at levels of no known or anticipated adverse health effects, with an adequate margin of safety.	No/Yes	Groundwater is a potential source of drinking water. MCLGs set at levels above zero are relevant and appropriate for potential sources of drinking water.
<b>STATE OF WYOMING</b>				
<b>WYOMING ENVIRONMENTAL QUALITY ACT</b>	W.S. 35-11-101 to 35-11-1803	--	--	--
	Article 2, W.S. 35-11-201 to 35-11-212	Addresses discharge or emission of air contaminants, including particulates	Yes/NA	Compliance with state air quality numeric and other substantive requirements identified as ARARs satisfies all requirements of this provision.
	Article 3, W.S. 35-11-301	Prohibits certain acts without a permit	Yes/NA	Compliance with state water quality substantive requirements (permits are not required) identified as ARARs satisfies all requirements of this provision.
<b>WYOMING WATER QUALITY RULES AND REGULATIONS</b>	Chapter I, Section 13	Toxic Materials	Yes/NA	Toxic materials cannot be present in surface waters in concentrations or combinations that constitute "pollution" (W.S. 35-11-103(C)(i)). Compliance with other state water quality substantive requirements satisfies all requirements of this provision.
	Chapter I, Section 18	Proposed changes to the regulations would add or modify standards based on protection of human health and aquatic life and re-classify some streams in the state, including Crow Creek. If promulgated, Crow Creek will go from Class 3 to Class 2AB, making it subject to additional standards	--	Until promulgated, this potential ARAR is to be determined (TBD).
	Chapter I, Section 21 (a-c)	Protection of Aquatic Life - Water Criteria	Yes*/NA	*Numeric standards listed in Appendix B, per Section 21(b), are applicable to Class 1, 2, or 3 waters only. Therefore, this is applicable only if the unnamed tributary is upgraded to Class 3.

**TABLE A8-1**  
**CHEMICAL-SPECIFIC ARARs**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citations	Description	Applicable/Relevant and Appropriate	Comments
	Chapter I, Section 26	pH	Yes/NA	For all waters, standard is 6.5-9.0.
	Chapter I, Section 29	Oil and Grease	Yes/NA	For all waters, cannot exceed 10 mg or form visible sheen or cause deposits or impact aquatic life. Primarily applicable during construction. May be applicable during any maintenance, although discharges are not anticipated.
	Chapter VIII	Water Quality Standards for Wyoming Groundwaters	Yes/NA	Groundwater is a potential source of drinking water. Regarding Section 1, compliance with other state water quality substantive requirements (permits are not required) identified as ARARs satisfies all requirements of this provision. Standards for Class 1 groundwater apply.
<b>WYOMING HAZARDOUS WASTE RULES AND REGULATIONS</b>	Chapter 1	Overview and Definitions	Yes/NA	If hazardous waste is generated, this chapter would apply. Applicable as necessary to implement other substantive requirements.
	Chapter 2	Identification and Listing of Hazardous Waste	Yes/NA	If hazardous waste is generated, this chapter would apply. Applicable in identifying listed or characteristic hazardous waste subject to other substantive requirements.

**Notes:**

ARARs = Applicable or relevant and appropriate requirements  
 CFR = Code of Federal Regulations  
 FS = Feasibility Study  
 MCL = Maximum Contaminant Level  
 MCLG = Maximum Contaminant Level Goal  
 mg/L = milligrams per liter  
 NA = Not applicable  
 Sec. = Section  
 USC = U.S. Code  
 W.S. = Wyoming Statute

**TABLE A8-2  
ACTION-SPECIFIC ARARs  
Zone B**

Requirement, Criteria, or Limitation	Citations	Description	Applicable/Relevant and Appropriate	Comments
<b>FEDERAL</b>				
<b>CLEAN WATER ACT</b>	33 USC Sec. 1251-1376	--	--	--
NPDES Storm Water Regulations	40 CFR 122	Establishes requirements for discharge of stormwater.	Yes/NA	Stormwater runoff may occur from the site, making substantive requirements applicable.
Criteria and Standards for the National Pollutant Discharge Elimination System	40 CFR 125	Provides discharge criteria, chemical standards, and permit forms for existing industrial operations.	Yes/NA	Although permits are not required, substantive provisions are applicable to remedial actions that cause discharge to waters of the U.S.
<b>CLEAN AIR ACT</b>	42 USC Sec. 7401-7642	--	--	--
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes standards for ambient air quality to protect public health and welfare (including standards for particulate matter and lead)	Yes/NA	Emissions from remedial action will be subject to NAAQS unless state standards are more stringent.
<b>STATE OF WYOMING</b>				
<b>WYOMING ENVIRONMENTAL QUALITY ACT</b>	Article 2, W.S. 35-11-201 to 35-11-212	Discharge or emission of air contaminants	Yes/NA	Compliance with state air quality numeric and other substantive requirements identified as ARARs satisfies all requirements of this provision.
	Article 3, W.S. 35-11-301	Prohibits certain acts without a permit.	Yes/NA	Compliance with state water quality substantive requirements (permits are not required) identified as ARARs satisfies all requirements of this provision.
<b>WYOMING WATER QUALITY RULES AND REGULATIONS</b>	Chapter I, Section 10	Testing Procedures	Yes/NA	However, where standard methods of testing have not been established, the suitability of testing procedures shall be determined by USAF in consultation with WDEQ and EPA using defensible scientific methods.
	Chapter I, Section 11 (a, b)	Flow Conditions	Yes/NA	During low flow conditions, the WDEQ may, in consultation with WG & FD, require dischargers to institute modifications as necessary to protect aquatic life.
	Chapter I, Section 14	Dead Animals and Solid Waste	Yes/NA	Cannot place dead animals or solid waste in any location that would cause or threaten contamination of surface waters. Primarily applicable during construction and maintenance activities.
	Chapter I, Sections 15, 16	Settleable Solids; Floating and Suspended Solids	Yes/NA	Any substances attributable to or influenced by the activities of man that will settle to form sludge, bank, or bottom deposits cannot be present in sufficient quantities that could result in significant aesthetic degradation, significant degradation in aquatic habitat, adversely affect problem water supplies, agricultural industrial water use, plant life, or wildlife. Primarily applicable during construction; may be applicable during any maintenance.

**TABLE A8-2  
ACTION-SPECIFIC ARARs  
Zone B**

Requirement, Criteria, or Limitation	Citations	Description	Applicable/Relevant and Appropriate	Comments
	Chapter I, Section 17 (a-c)	Taste, Odor, and Color	*Yes/NA	Cannot impart an unpalatable or off flavor in fish flesh or public water supplies; visibly alter the natural color of the water; impart color to skin, clothing, or vessels; or produce detectable odors. *Applicable to Class 1, 2, and 3 waters only. Therefore, this is applicable only if the unnamed tributary is upgraded to Class 3.
	Chapter I, Section 23 (b)	Turbidity	*Yes/NA	*This section provides standards that apply to Class 1, 2, and 3 waters only. Subsection (b) applies to Class 3 waters and Class 1 and 2 waters that are warm water fisheries. Therefore, Subsection (b) is applicable only if the unnamed tributary is upgraded to Class 3.
	Chapter I, Section 25	Temperature	*Yes/NA	*This section provides standards that apply to Class 1, 2, and 3 waters only. Subsection (a) applies to Class 1, 2, and 3 waters and Subsection (c) applies to Class 3 warm water fisheries. Therefore, these subsections are applicable only if the unnamed tributary is upgraded to Class 3.
	Chapter I, Section 28	Undesirable Aquatic Life	Yes/NA	All surface waters must be free from substances and conditions and combinations thereof which are attributable to discharges in concentrations that produce undesirable aquatic life.
	Chapter III, Section 4(e), 6(d), 7(c), 8(a-f), 15	Regulations for permit to construct, install, or modify Public Water Supplies, Wastewater Facilities, and Other Facilities Capable of Causing or Contributing to Pollution of facilities capable of causing or contributing to pollution	Yes/NA	Although permits are not required, substantive requirements of regulation apply.
	Chapter IV, Sections 4(a) (i, iii), (b-c), 5, 7, 8	Regulations for releases of oil and hazardous substances into waters of the State	Yes/NA	Compliance with other water quality substantive requirements identified as ARARs satisfies all requirements of Section 5.
	Chapter XI, Part G	Standards for the Design and Construction and for the Abandonment of Monitor Wells	Yes/NA	Substantive requirements apply (permits are not required) if monitor wells are constructed or abandoned.
<b>WYOMING AIR QUALITY STANDARDS AND REGULATIONS</b>	Chapter 1, Section 5	Abnormal conditions and equipment malfunctions	Yes/NA	Primarily applicable during construction and any maintenance of remedial action alternative.
	Chapter 2, Section 11 (a), (c)	Odors	Yes/NA	Applicable if any alternative creates odors. No monitoring is required.
	Chapter 3, Section 2	Control of particulate emissions, including fugitive dust	Yes/NA	Primarily applicable during construction and maintenance of remedial action alternative.
	Chapter 6, Section 2 (c) (v) and (j)	Requirements for construction, modification, and operations	Yes/NA	Although permits are not required, substantive requirements apply.

**TABLE A8-2**  
**ACTION-SPECIFIC ARARs**  
**Zone B**

Requirement, Criteria, or Limitation	Citations	Description	Applicable/Relevant and Appropriate	Comments
<b>WYOMING HAZARDOUS WASTE RULES AND REGULATIONS</b>	Chapter 1	Overview and Definitions	Yes/NA	If hazardous waste is generated, this chapter would apply. Applicable as necessary to implement other substantive requirements.
	Chapter 8	Standards for Generators of Hazardous Waste	Yes/NA	If hazardous waste is generated, this chapter would apply.
	Chapter 9	Standards for Transporters of Hazardous Waste	Yes/NA	If hazardous waste is generated, this chapter would apply.
	Chapter 11, Sections 4(g), 5, 6, 9(b) and (c), 10, 11 (except (h)(iii) and (k), 24, 31	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Yes/NA	If hazardous waste is generated, these provisions would apply. Chapter 8, Section 3(e) refers to these requirements for a generator that accumulates hazardous waste on site for 90 days or less.
	Chapter 13	Land Disposal Restrictions	Yes/NA	If hazardous waste is generated, these provisions would apply.
<b>WYOMING SOLID WASTE MANAGEMENT RULES AND REGULATIONS</b>	Chapter 1, Section 1(h)	General Provisions – Prohibited Acts.	Yes/NA	Applicable to all alternatives. Prohibits open dumping of garbage or trash generated during construction or maintenance activities.

**Notes:**

ARARs = Applicable or relevant and appropriate requirements  
 CFR = Code of Federal Regulations  
 EPA = U.S. Environmental Protection Agency  
 NA = Not applicable  
 NAAQC = National Ambient Air Quality Standards  
 NPDES = National Pollution Discharge Elimination System  
 Sec. = Section  
 USAF = U.S. Air Force  
 USC = U.S. Code  
 WDEQ = Wyoming Department of Environmental Quality  
 W.S. = Wyoming Statute

**TABLE A8-3**  
**LOCATION-SPECIFIC ARARs (and TBCs)**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
<b>FEDERAL</b>				
<b>CLEAN WATER ACT—DREDGE AND FILL REGULATIONS</b>	40 CFR 230; 33 CFR 320-330	Establishes requirements for permits to authorize the discharge of dredged or fill material into waters of the U.S., which includes inland wetlands.	Yes/NA	Applicable to any alternative with potential to discharge dredged or fill material into waters of the U.S., including existing wetlands; permits are not required. Wetlands maintained by artificial water source (e.g., pumped groundwater) are not protected.
<b>ENDANGERED SPECIES ACT</b>	16 USC 1531-1543; 50 CFR Parts 17, 402	Requires that federal agencies ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat.	Yes/NA	Several listed or proposed endangered and/or threatened species have been observed in the vicinity of the proposed remedial action. The Colorado butterfly plant is proposed for listing as a threatened species and has been observed at Landfill 5b. Its potential habitat includes riparian habitat along Crow Creek and its tributaries. In addition, potential habitat for the Preble's meadow jumping mouse, a threatened species, has been observed in the area of Landfill 5b, including the riparian area along the unnamed tributary. The potential effects on endangered/threatened species or their habitat will depend on the alternative selected and locations considered for the preferred alternative.  Although consultation with the USFWS is not an applicable requirement for a CERCLA response action, USAF will consult with the USFWS to ensure that the remedial action meets the substantive requirements of the Endangered Species Act with respect to any identified listed or proposed endangered or threatened species.
<b>FISH AND WILDLIFE COORDINATION ACT</b>	16 USC 661 et seq.	Requires development of measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife if an action will result in the control or structural modification of a natural stream or body of water.	No/No	Although consultation with the USFWS and Wyoming Game and Fish Department is not a requirement for any alternative, USAF will consult with the USFWS and Wyoming Fish and Game Department to develop measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife.
<b>MIGRATORY BIRD TREATY ACT</b>	16 USC 703-712	Provides protection for migratory bird species (includes geese, ducks, raptors, many passerines). Prohibits killing or taking of bird or any part, nest, or egg of any such bird.	Yes/NA	Applicable to any alternative that could impact migratory birds present in area. Will be addressed during coordination with USFWS.
<b>NATIONAL HISTORIC PRESERVATION ACT</b>	16 USC 470 et seq.; 36 CFR Part 63, Part 65, Part 800	Requires federal agencies to take into account the effect any federal undertaking may have on any historic properties included in or eligible for the National Register of Historic Places.	Yes/NA	The Base Historic Preservation Officer will determine whether any remedial action alternatives (e.g., drilling borings, installing trenches, constructing wetlands) will affect historic properties and coordinate that determination with the State Historic Preservation Officer.

**TABLE A8-3**  
**LOCATION-SPECIFIC ARARs (and TBCs)**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
<b>ARCHEOLOGICAL AND HISTORICAL DATA PRESERVATION ACT</b>	14 USC 469 – 469 c-1	Establishes procedures to provide for preservation of historical and archeological data that might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity program.	Yes/NA	The Base Historic Preservation Officer will determine whether any remedial action alternatives (e.g., drilling borings, installing trenches, constructing wetlands) will potentially destroy historical and/or archaeological data and if so, USAF will take measures to ensure it is evaluated and preserved.
<b>ARCHEOLOGICAL RESOURCES PROTECTION ACT (1979)</b>	16 USC 470 aa – 470 ll	Provides requirements for any excavation or removal of archeological resources from public or Indian lands.	Yes/NA	Although permits are not required for this on-site remedial action, the Base Historic Preservation Officer will determine whether any remedial action alternatives will necessitate excavation or removal of archaeological resources and, if so, USAF will comply with substantive requirements for excavation, removal, and preservation.
<b>STATE OF WYOMING</b>				
<b>WYOMING WATER QUALITY RULES AND REGULATIONS</b>	Chapter I, Appendix A	Classification for the unnamed tributary to Crow Creek	*Yes/NA	*If the unnamed tributary to Crow Creek is reclassified from Class 4 to Class 3, ARARs as listed herein for the upgraded stream classifications (designated with an asterisk - *) would be applicable.
	Chapter I, Section 12	Protection of Wetlands	Yes/NA	An authorized wetlands mitigation process includes any process under Section 404 of the Federal Clean Water Act or under U.S. Army Corps of Engineers wetlands regulations.
<b>TO BE CONSIDERED</b>				
<b>EXECUTIVE ORDER ON FLOODPLAIN MANAGEMENT</b>	Exec. Order No. 11988	Requires federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid, to the extent possible, the adverse impacts associated with direct and indirect development of a floodplain.	No/No (TBC)	Based on a memorandum from the Deputy Assistant Secretary of the Air Force (Environment, Safety, and Occupational Health), dated 24 August 1999 entitled "Findings of No Practicable Alternatives (FONPAs) and CERCLA Installation Restoration Program (IRP) Activities", this Executive Order is to be viewed as "to be considered", not an ARAR, for Air Force IRP actions under CERCLA. The USAF will comply with the substantive requirements of this Executive Order and document compliance with the substantive requirements in the administrative record. This will include documentation in the Record of Decision that there are no practicable alternatives and that all practicable measures will be taken to minimize harm, if construction in floodplains is included as part of the selected remedial action alternative.

**TABLE A8-3**  
**LOCATION-SPECIFIC ARARs (and TBCs)**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
<b>EXECUTIVE ORDER ON PROTECTION OF WETLANDS</b>	Exec. Order No. 11990	Requires federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists.	No/No (TBC)	Based on a memorandum from the Deputy Assistant Secretary of the Air Force (Environment, Safety, and Occupational Health) dated 24 August 1999 entitled "Findings of No Practicable Alternatives (FONPAs) and CERCLA Installation Restoration Program (IRP) Activities", this Executive Order is to be viewed as "to be considered", not an ARAR, for Air Force IRP actions under CERCLA. The Air Force will comply with the substantive requirements of this Executive Order and document compliance with the substantive requirements in the administrative record. This will include documentation in the Record of Decision that there are no practicable alternatives and that all practicable measures will be taken to minimize harm, if construction in wetlands is included as part of the selected remedial action alternative.

**Notes:**

ARARs	= Applicable or relevant and appropriate requirements
CERCLA	= Comprehensive Environmental Restoration, Compensation and Liability Act
CFR	= Code of Federal Regulations
EPA	= United States Environmental Protection Agency
NA	= Not applicable
TBC	= To be considered
USAF	= U.S. Air Force
USC	= U.S. Code
USFWS	= U.S. Fish and Wildlife Service

**Chemical, Action, and Location Specific ARARs  
for the Waste Co-Location Area (WCA)**

# Poor Quality Source Document

The following document  
images have been  
scanned from the best  
available source copy.

To view the actual hard copy,  
contact the Superfund Records  
Center at (303) 312-6473.

**TAB A8-4**  
**POTENTIAL CHEMICAL-SPECIFIC ARARs**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate	Comments
<b>Federal</b>				
Clean Air Act	40 CFR Part 50	--	--	--
National Primary and Secondary Ambient Air Quality Standards		Establishes standards for ambient air quality to protect public health and welfare, including standards for particulate matter and lead	Yes/NA	Emissions from excavation of dust generated through excavation of other landfill materials will be subject to National Ambient Air Quality Standards unless state standards are more stringent.
Standards of Performance for New Stationary Sources	40 CFR Part 60, Subpart WWW	Establishes performance standards for venting of landfill gases as a type of new stationary source	Yes/NA	Options for disposal of excavated landfill material that include covering may also include venting or treating landfill gases.
<b>State of Wyoming</b>				
Wyoming Air Quality Standards and Regulations	Chapter 1, Section 3	Establishes ambient air standards for particulate matter	Yes/NA	Applicable to the emissions from excavation of contaminated soils.
	Chapter 1, Section 14	Establishes requirements for the control of particulate emissions	Yes/NA	Applicable to the emissions from excavation of contaminated soils.
	Chapter 1, Section 16 (a), (c)	Establishes ambient air standards for odors	Yes/NA	Applicable to the emissions from excavation of contaminated soils.
	Chapter 1, Section 22	Establishes New Source Performance Standards for municipal solid waste landfills	Yes/Yes	Would be applicable if the disposal option of placing waste at the WCA is selected. May be relevant and appropriate to the emissions from existing municipal solid waste landfills.
Wyoming Environmental Quality Act	Article 5, W.S. 35-11-516, 519	Set requirements for hazardous waste generators, transporters, and corrective action	Yes/NA	If hazardous waste is generated during excavation, these provisions would apply. Compliance with state hazardous waste substantive requirements identified as ARARs satisfies all requirements of these provisions.
	Article 3, 35-11-301	Prohibits certain acts without a permit	Yes/NA	Compliance with state water quality substantive requirements identified as ARARs satisfies all requirements of this provision.
Wyoming Water Quality Rules and Regulations	Chapter 1, Section 18	Establishes human health values	Yes/NA	Not applicable unless affected waters are upgraded to Class 2. Applies in relation to excavation and/or cover construction activities, but subsequent investigation and remedial actions (if necessary) will address any past contamination of surface water resulting from landfills.

**TABLE A8-4**  
**POTENTIAL CHEMICAL-SPECIFIC ARARs**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate	Comments
	Chapter I, Section 21(a, c)	Protection of aquatic life	Yes/NA	Ammonia is not anticipated and monitoring is not required. Applies in relation to excavation and/or cover construction activities, but subsequent investigation and remedial actions (if necessary) will address any past contamination of surface water resulting from landfills.
	Chapter I, Section 24	Establishes limits for dissolved oxygen	Yes/NA	Rules and regulations are not applicable unless affected waters are upgraded to Class 2. Applies in relation to excavation and/or cover construction activities, but subsequent investigation and remedial actions (if necessary) will address any past contamination of surface water resulting from landfills.
	Chapter I, Section 25	Establishes limits for temperature	Yes/NA	Applies in relation to excavation and/or cover construction activities, but subsequent investigation and remedial actions (if necessary) will address any past contamination of surface water resulting from landfills.
	Chapter I, Section 27	Establishes limits for coliform bacteria	Yes/NA	Applies in relation to excavation and/or cover construction activities, but subsequent investigation and remedial actions (if necessary) will address any past contamination of surface water resulting from landfills.
	Chapter I, Section 29	Establishes limits for oil and grease	Yes/NA	Applies in relation to excavation and/or cover construction activities, but subsequent investigation and remedial actions (if necessary) will address any past contamination of surface water resulting from landfills.
Wyoming Hazardous Waste Rules and Regulations	Chapter 1	Overview and Definitions	Yes/NA	If hazardous waste is generated during excavation, this chapter would apply. It is applicable as necessary to implement other substantive requirements.
	Chapter 2	Identifies and lists of hazardous waste	Yes/NA	If hazardous waste is generated during excavation, these provisions would apply. Provisions are applicable in identifying listed or characteristic hazardous waste subject to other substantive requirements.

**Notes:**

ARARs = Applicable or relevant and appropriate requirements  
 CFR = Code of Federal Regulations  
 NA = Not applicable  
 WCA = Waste Co-location Area  
 W.S. = Wyoming statute

T A8-5  
**POTENTIAL ACTION-SPECIFIC ARARs**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate	Comments
<b>Federal</b>				
Clean Water Act	33 USC Section 1251-1376	Establishes requirements for the discharge of storm water	--	Substantive requirements apply.
NPDES Storm Water Regulations	40 CFR Part 122	Establishes requirements for discharge of storm waters	Yes/NA	Storm water may occur from the site, making substantive requirements applicable.
Dredge and Fill	40 CFR Part 230, 40 CFR 320 to 330	Establishes requirements for permits to authorize the discharge of dredged or fill material into navigable waters	Yes/NA	Substantive requirements are applicable to actions involving the disturbance of wetlands, which are found in the vicinity of LFs 2a and 2b.
Clean Air Act	42 USC 7401-7642	--	--	--
National Emissions Standards for Hazardous Air Pollutants	40 CFR, Part 61, Subpart A	Establishes emissions standards for hazardous air pollutants	No/Yes	Standards are relevant and appropriate during the excavation of the landfill materials and during transport if asbestos materials are encountered during excavation activities.
<b>State of Wyoming</b>				
Wyoming Environmental Quality Act	Article 2, W.S. 35-11-201	Addresses discharge or emission of air contaminants	Yes/NA	Compliance with state air quality numeric and other substantive requirements identified as ARAR satisfies all requirements of this provision.
	Article 3, W.S. 35-11-301 to 35-11-311	Prohibits certain acts without a permit	Yes/NA	Compliance with state water quality substantive requirements (permits are not required) identified as ARARs satisfies all requirements of this provision.
	Article 5, W.S. 35-11-502(a)	Solid waste management facilities	Yes/NA	Only substantive requirements apply. Permits are not required.
	Article 5, W.S. 35-11-516, 519	Provides requirements for hazardous waste generators, transporters, and corrective action	Yes/NA	If hazardous waste is generated during excavation, this chapter would apply. It is applicable as necessary to implement other substantive requirements.

**TABLE A8-5**  
**POTENTIAL ACTION-SPECIFIC ARARs**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate	Comments
Wyoming Water Quality Rules and Regulations	Chapter I, Section 10	Provides requirements for testing procedures	Yes/NA	Where standard methods of testing have not been established, USAF shall determine the suitability of testing procedures in consultation with WDEQ and EPA using defensible scientific methods.
	Chapter I, Section 11(a, b)	Provides requirements for flow conditions	Yes/NA	Applicable during excavation and construction activities.
	Chapter I, Section 12	Provides requirements for protection of wetlands	Yes/NA	An authorized wetlands mitigation process includes any process under Section 404 of the federal Clean Water Act or under U.S. Army Corps of Engineers wetlands regulations. Wetlands are located in the vicinity of LFs 2a and 2b. As provided in Section V.A.5 of this Action Memorandum, USAF will take steps to minimize adverse impacts on wetlands, restore any disturbed areas, and increase wetland areas.
	Chapter I, Section 14	Provides requirements for dead animals and solid waste	Yes/NA	Regulations are applicable during excavation or construction and any maintenance of the selected removal action.
	Chapter I, Section 15, 16, 17 (a, c)	Provides requirements for settleable solids, floating and suspended solids, and taste, odor and color	Yes/NA	Regulations are applicable during excavation or construction and any maintenance of the selected removal action alternative.
	Chapter I, Section 23(a, b)	Provides requirements for turbidity	Yes/NA	Section 23(a) is not applicable unless affected waters are upgraded to Class 2.
	Chapter I, Section 28	In surface waters, prohibits substances and conditions, which are attributable to discharges, in concentrations that produce undesirable aquatic life	Yes/NA	If undesirable aquatic life is specifically attributable to the selected removal action alternative these requirements would apply.
	Chapter III, Sections 4(c), 6(d), 7(c), 8(a-f)	Provides requirements for construction, installation or modification of facilities capable of causing or contributing to pollution	Yes/NA	Substantive provisions apply, but no permits are required.

TABLE A8-5  
POTENTIAL ACTION-SPECIFIC ARARs  
Zone B

Standard, Requirement, Criteria, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate	Comments
	Chapter IV, Sections 4(a)(i, iii), (b-c), 5, 7, 8	Provides requirements to stop and contain releases of oil and hazardous substances and immediately correct the cause of the release. In addition, provides requirements related to cleanup of the release and disposal of contaminated materials.	Yes/NA	Regulations are applicable during excavation or construction and any maintenance of the selected removal action alternative. Compliance with other water quality substantive requirements identified as ARARs satisfies all requirements of Section 5.
Wyoming Solid Waste Rules and Regulations	Chapter 2, Section 5	Provides requirements for operating standards, daily cover requirements	Yes/NA	If the disposal option for excavated materials is placement at WCA, daily cover standards are applicable.
	Chapter 2, Section 7	Provides requirements for closure and post-closure standards for sanitary landfills	No/Yes(1) Yes/NA(2)	(1) Substantive closure and post-closure standards for landfills that ceased receipt of wastes before October 9, 1991, are relevant and appropriate to removal of LF2a/LF2b, LF3, and LF5b. (2) Substantive closure and post-closure requirements for landfills that received waste after October 9, 1991, are applicable to the disposal option of final disposition at WCA.
	Chapter 8, Sections 3(b)(i, ii) and 4(c)(iii-v)	Provides disposal standards for asbestos-containing wastes	Yes/NA	Substantive requirements apply if landfill contains asbestos-containing wastes.
Wyoming Air Quality Standards and Regulations	Section 14	Provides requirements for control of particulate emissions	Yes/NA	Regulations are applicable during excavation activities for all removal action alternatives.
	Section 16(a,c)	Provides requirements for odors	Yes/NA	Regulations are applicable during excavation activities for all removal action alternatives.
	Section 19	Provides requirements for abnormal conditions	Yes/NA	Regulations are applicable during excavation activities for all removal action alternatives.
	Section 21(c)(v) and (j)	Provides requirements for permit requirements for construction, modification and operations	Yes/NA	Although permits are not required, substantive requirements of BACT apply.

**TABLE A8-5**  
**POTENTIAL ACTION-SPECIFIC ARARs**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citations	Description	Applicable/ Relevant and Appropriate	Comments
	Chapter 1, Section 29	Provides requirements during removal, transport, and disposal of asbestos containing material	No/Yes	Relevant and appropriate if asbestos materials are encountered during excavation activities.
Wyoming Hazardous Waste Rules and Regulations	Chapter 1	Provides overview and Definitions	Yes/NA	If hazardous waste is generated during excavation, this chapter would apply. Applicable as necessary to implement other substantive requirements.
	Chapter 8	Sets standards for generators of hazardous waste	Yes/NA	If hazardous waste is generated during excavation, this chapter would apply. These provisions incorporate DOT Hazardous Material Regulations found in 49 CFR Part 170-177 by reference.
	Chapter 9	Sets standards for transporters of hazardous waste	Yes/NA	If hazardous waste is generated during excavation, this chapter would apply.
	Chapter 10	Sets standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	Yes/NA	If hazardous waste is generated during excavation, this chapter would apply if the hazardous waste is treated on site, except when treated in a container, or if hazardous waste is stored for longer than 90 days (although that length of storage is not anticipated).
	Chapter 11, Sections 4(g), 5, 6, 9(b) and (e), 10, 11 (except (h)(iii) and (k), 24, 31	Sets interim status standards for owners and operators of hazardous waste treatment, storage, and disposal facilities	Yes/NA	If hazardous waste is generated during excavation, these sections would apply.
	Chapter 13	Addresses land disposal restrictions	Yes/NA	If hazardous waste is generated during excavation, this chapter would apply.

**Notes:**

ARARs = Applicable or Relevant and Appropriate Requirements  
 BACT = Best available control technology  
 CFR = Code of Federal Regulations  
 DOT = Department of Transportation  
 EPA = United States Environmental Protection Agency  
 NA = Not applicable  
 NPDES = National Pollutant Discharge Elimination System  
 USC = United States Code  
 WCA = Waste Co-location Area

WDEQ = Wyoming Department of Environmental Quality  
 W. S. = Wyoming Statute

TA A8-6  
**POTENTIAL LOCATION-SPECIFIC ARARs**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
<b>Federal</b>				
National Historic Preservation Act	16 USC Section 470 36 CFR Part 800 32 CFR Part 229	Requires federal agencies to take into account the effect of any federally-assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for the Register of Historic Places.	Yes/NA	<del>FEW is on the National Register of Historic Places. FEW must take into account the effects of removal activities on historical properties.</del> <u>USAF has determined that the landfills in question are not eligible for listing in the National Register of Historic Places, and USAF is in the process of coordinating this determination with the State Historic Preservation Officer. Therefore, no additional protective measures should be necessary under this Act.</u>
Archaeological and Historic Preservation Act	16 USC Section 469	Establishes requirements for the evaluation and preservation of historical and archaeological data, which may be destroyed through alteration of terrain as a result of a Federal construction project	Yes/NA	<del>Preservation of archaeological data may be necessary during implementation of removal action.</del> <u>USAF has determined that the landfills in question are not eligible for listing in the National Register of Historic Places, and USAF is in the process of coordinating this determination with the State Historic Preservation Officer. Therefore, no additional protective measures should be necessary under this Act.</u>
Historic Sites, Buildings, and Antiquities Act	16 USC Section 461	Requires federal agencies to consider the existence and location of landmarks on the National Registry of National Landmarks to avoid undesirable impacts on such landmarks.	Yes/NA	
Clean Water Act	40 CFR Part 230 33 CFR 320-330	Prohibits the discharge of dredged or fill material into wetlands without a permit	Yes/NA	Substantive requirements apply to actions involving disturbance of wetlands.

**TABLE A8-6**  
**POTENTIAL LOCATION-SPECIFIC ARARs**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
Endangered Species Act	16 USC Section 1531; 50 CFR Parts 17 and 402	Requires that federal activities not jeopardize the continued existence of any threatened or endangered species.	Yes/NA	Habitat of the Colorado Butterfly Plant, which has been proposed for listing as a threatened species, has been observed at LF5b. In addition, potential habitat for the Preble's Meadow Jumping Mouse, which is listed as a threatened species, has been observed in the area of LFs 2a and 5b. Although formal consultation with the U.S. Fish and Wildlife Service (FWS) is not an applicable requirement for a CERCLA removal action, USAF is in the process of formal consultation with the FWS to ensure that the removal action meets the substantive requirements of the Endangered Species Act with respect to these species.

**TABLE A8-6**  
**POTENTIAL LOCATION-SPECIFIC ARARs**  
**Zone B**

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Comments
State of Wyoming				
Wyoming Water Quality Rules and Regulations	Chapter 1, Appendix A	Provides classifications for surface waters	Yes/NA	Classifications of Diamond Creek, Crow Creek, and Unnamed Tributary apply. If stream classifications are upgraded, ARARs for upgraded stream classifications will apply.
	Chapter 1, Section 12	Addresses protection of wetlands	Yes/NA	An authorized wetlands mitigation process includes any process under Section 404 of the federal Clean Water Act or under U.S. Army Corps of Engineers wetlands regulations. Wetlands are located in the vicinity of LFs 2a and 2b. As provided in Section V.A.5 of this Action Memorandum, USAF will take steps to minimize adverse impacts on wetlands, restore any disturbed areas, and increase wetland areas.
	Chapter 2, Section 3	Prohibits the construction or location of sanitary waste disposal facilities in several areas, including wetlands and flood plains	Yes/NA	Substantive provisions applicable to disposal options involving placing waste on LF2a/LF2b.

**Notes:**

ARARs = Applicable or Relevant and Appropriate Requirements  
 CFR = Code of Federal Regulations  
 FWS = U.S. Fish and Wildlife Service  
 NA = Not applicable  
 USC = United States Code

## **ATTACHMENT A9**

### **Cost Effectiveness Matrix**

TABLE A9-1

Alternative	Present Worth Cost	Incremental Cost	Long-Term Effectiveness and Performance	Reduction of TMV through Treatment	Short-Term Effectiveness
1 – No Action	\$0	--	<ul style="list-style-type: none"> <li>None – no long-term reduction of risk</li> </ul>	Rely on natural processes only	No short-term risk
2 – Institutional Control	\$35,623	+\$35,623	<ul style="list-style-type: none"> <li>Poor – long-term risk reduction requires 50 years and there is no confirmation through monitoring</li> </ul>	Rely on natural processes only	No short-term risk
3 – Natural Attenuation/ LTM	\$1,552,966	+\$1,552,966	<ul style="list-style-type: none"> <li>Acceptable – eventual long-term risk reduction over 50 years, with monitoring</li> </ul>	Rely on natural processes only	Little short-term risk (monitoring construction)
4 – Groundwater Extraction and Treatment	\$1,729,257	\$1,729,257	<ul style="list-style-type: none"> <li>Good – excellent (7 years to reach RAO)</li> </ul>	Good – must dispose of spent GAC	Some short-term disturbance – little land disturbance. Reach RAO in 7 years.
5 – In Situ PRB	\$2,008,097	+\$2,008,097	<ul style="list-style-type: none"> <li>Good – excellent, if no problems with technology (25 years to reach RAO)</li> </ul>	Good to excellent – no hazardous residues	Some short-term impacts – larger land disturbance near Unnamed Tributary for construction

#### Cost Effectiveness Summary

Alternative 1 and 2 are not cost-effective.

Alternative 3 is cost-effective, but requires a substantially longer time to meet RAO of 5 µg/L for the cost involved.

Alternative 4 is not as cost-effective as Alternative 5 – more costly, longer time to reach RAO, less proven.

Alternative 5 is most cost-effective – good effectiveness with relatively short time to meet RAO at reasonable comparative cost.

## **ATTACHMENT A10**

**Response to EPA and WDEQ Comments**

## RESPONSE TO EPA COMMENTS ON THE FINAL ZONE B ROD

### Operable Unit 8, Landfill 5 F. E. Warren Air Force Base 05 July 2001

Most of these comments pertain to follow-up on comments offered on the draft version of this ROD. Because the revisions indicate good faith in addressing EPA comments, EPA is offering suggestions for modifications rather than identifying or initiating a dispute. These mainly pertain to internal consistency and clarity. Some comments are mainly editorial and are offered to improve clarity or readability.

Comments are keyed to the document by Page, Section (Sec.), Column (Col.), paragraph, sentence, figure, table, or line as indicated. The general outline structure of the ROD was followed to identify specific comments.

#### General Comment

1. There is an apparent inconsistency between the description of institutional controls in the Declaration and Decision Summary. The discussion must (1) clearly identify the mechanism by which institutional controls will be enacted. This can be through the BGP or the Environmental Restoration Land Use Control Plan (ERLUCP), if the ERLUCP is identified as a component of the BGP and is thus similarly enforceable. (2) Describe performance standards for the controls (this is mainly done, which is the prevent access and exposure, etc); and (3) Better define authorized vs. unauthorized (i. e., clarify that access/activities are generally prohibited except those which are:

(3.1) consistent with the monitoring, operation, and maintenance of the remedy or facilities associated with the remedy ; or

(3.2) approved construction or digging through the Environmental Flight (i.e. John's group) which may require the use of PPE or other conditions placed on activities; or

(3.3) otherwise accepted in consultation with EPA and WDEQ.

The draft language proposed (See Comment 10) also refer to the Air Force in general for access or ground water use, but identifies the base RPM or Environmental Flight as the "approving" authority. This needs to be clarified by the Air Force, since the administrative structures may be subject to change (e. g., reorganization).

**Response:** Comment acknowledged. Text in the ROD has been modified according to the specific comments to provide greater consistency and clarity.

#### Specific Comments

2. Sec. ID., Description of the Selected Remedy, Page 1. Delete the second sentence. It is redundant with the last three sentences.

**Response:** The referenced sentence has been deleted.

3. Sec. I.D., Description of the Selected Remedy, Page 2. The fifth main bulletin discussing institutional controls needs to be rephrased, because the intent of the controls is not solely preventing exposure to contaminated ground water. They are intended to prevent exposure to contaminants in the WCA and to protect facilities which need to be maintained for the remedy to remain effective. Suggested rephrasing is to the effect of "*Institutional controls to prevent exposure to contaminants and assure effectiveness of the remedy, including:*"

**Response:** The referenced sentence has been rephrased as suggested.

The last bulletin will need to identify the actual plan or document by which the institutional controls will be enacted. If this is the Base General Plan (BGP), then the existing phrasing is accurate. If it will be another plan which appends the BGP (such as Composite Constraints and Controls Plan or Environmental Restoration Land Use Control Plan), this will need to be identified.

The bulletin discussing the annual review of the Base General Plan (BGP) should be a sub-bulletin under the institutional controls.

**Response:** The last bulletin now includes the following text, "Placement of restrictive notices in the Base General Plan (BGP), and in particular the Composite Constraints and Opportunities Plan (CCOP, a component of the BGP) to prevent. . .".

4. Sec. II.D., Page 7, Scope and Role of Operable Unit. In the 4<sup>th</sup> sentence, "the third ROD" should be changed to "the fourth ROD" to be consistent with subsequent discussion. EPA acknowledges "third" was used consistently with EPA's comment on the draft document, but EPA mis-counted.

**Response:** The "third" ROD has been changed to the "fourth".

5. Sec. II.D. (Scope and Role...), last paragraph on Page 8, 3<sup>rd</sup> sentence. Add "(USAF, 2000c)" after "the Action Memorandum" to provide the reader an appropriate reference.

**Response:** The reference has been added.

6. Sec. II.E., Site Characteristics, Groundwater Modeling, Page 13. The statement "The LF5c unit does not exist." does not fit with the discussion of ground water modeling. It belongs in the site overview or can simply be deleted from this location. The next paragraph seems redundant with the first assumption for the model. This paragraph can be deleted without loss of meaning to the discussion or the document.

The last paragraph appears to be intended to provide the reader a resource for finding the information upon which the observation of attenuation being consistent with empirical data is based. There needs to be a statement to that effect.

**Response:** The referenced sentence and paragraph have been deleted. The last paragraph has been modified and appended to the second previous paragraph.

7. Sec. II.L., Summary of the Rationale for the Selected Remedy, Page 28. The two paragraphs following the bulletins appear to be remnants from the earlier structure. They discuss institutional controls, which are not part of the "rationale". Elements of this discussion (appropriately modified to identify the actual document/mechanism which will be used) belongs in a section which discusses institutional controls for the remedy.

**Response:** The two referenced paragraphs have been moved and incorporated into Section I which describes the alternatives, including institutional controls.

8. Sec. II.L., Description of the Selected Remedy (Pages 28 and 29). This discusses most of the major components of the remedy, but not institutional controls. The discussion currently under "Performance Monitoring Goals" belongs in a separate subsection entitled "Institutional Controls".

**Response:** The discussion addressing institutional controls under "Performance Monitoring Goals" has been moved to Section I, Description of Alternatives. An abbreviated description and separate subsection entitled "Institutional Controls"

has been included in the subsection "Description of the Selected Remedy" prior to the subsection "Performance Monitoring". Additionally, the discussion of institutional controls pertaining to the WCA has been moved to reflect a similar organizational format.

9. Sec. II.L., Performance Monitoring Goals, Page 29. Add a bulletin to address the administrative monitoring of the institutional controls, perhaps to the effect of *"Assessment of the effectiveness of the institutional controls in preventing exposures and assure maintenance of facilities which need to be maintained to assure effectiveness of the remedy."*

**Response:** The suggested bulletin with minor modification has been added to address the administrative monitoring of the institutional controls.

10. Sec. II. L., Performance Monitoring Goals, Pages 30 and 31. Most of this discussion is what belongs in a section discussing institutional controls (See Comment 8 above). The first paragraph on Page 30 which discusses the WCA is probably not needed since the controls for the WCA are discussed later. The remaining discussion needs to be rephrased into plainer English. Move the specific citations of the Air Force Instructions (APIs) to the section for References. Draft suggested language is as follows:

*The Air Force comprehensive planning process and BGP are similar to civilian local land use and planning processes, such as zoning, easements, rights-of-way, use of natural resources, and permitting for construction activities, such as digging. They have the effect of a direct order of the Secretary of the Air Force through a set of Air Force Instructions (APIs) and compliance is mandatory. The Installation Commander is responsible to ensure the comprehensive planning documents are developed, maintained and implemented. The Installation Commander must approve the BGP. A requirement of the APIs is to identify IRP sites (sites of known or potential contamination), where notes regarding specific institutional controls are placed as needed. These controls may be simply informational or serve as legal/management controls to restrict access, activities, and use of natural resources.*

*The institutional controls for the IRP sites at F. E. Warren Air Force Base will be enacted by modifying the Base General Plan, either directly or through an addendum to the BGP (such as an Environmental Restoration Land Use Control Plan). Specific language will prohibit unauthorized access to the facilities for the remedy at the IRP site or use of natural resources. Known or possible areas of contamination will be placed on the Land Use Map. The BGP and Land Use Map will be updated as necessary, but no less than annually, to incorporate institutional controls and monitor their implementation and effectiveness. These controls cannot be removed without prior approval by the Air Force (the Air Force Remedial Project Manager or Chief of Compliance) with acceptance of the changes by EPA and WDEQ.*

*Normal monitoring and operation and maintenance activities or other environmental activities conducted under plans accepted by EPA and WDEQ will be authorized activities. The BGP modifications will otherwise prohibit the use of ground water. Because municipal supplies are readily available, there are no current plans for use of ground water at FEW.*

*Modifications to the BGP will also prohibit access to facilities and construction or earth disturbances in certain areas (e. g., which would disturb the engineered cover on the WCA). In some cases, such as landfills which will remain in place in perpetuity, notices of the restrictions will be filed in the real property records in Laramie county. Fencing will be used as controls to prevent unauthorized access and potential exposure. In addition to minimizing potential exposures to humans,*

these restrictions will protect the facilities which are part of the remedy. Necessary activities can be conducted with approval of the Air Force, generally in consultation with EPA and WDEQ. These may be addressed in the BGP or through the permitting process at FEW, which is required for digging and earth work. Some activities may be approved but require air monitoring or the use of personal protective equipment for workers or other constraints to assure worker health and safety requirements are met.

Advisory or informational controls will be used in addition to the legal/ management controls. These include signs to identify access restrictions and warning of potential hazards in source areas. Also, community information and educational programs will enhance community understanding and awareness of the potential hazards.

Although considered unlikely, institutional controls would need to be revised in the event of property transfer. The installation was created by an act of Congress, and thus no conventional property deed exists. In the event of transfer, a deed with restrictive covenants may need to be created. CERCLA Section 120( h) requires the Air Force to provide notice of hazardous substance releases and assurances that all remedial action has taken place or will be completed in any deed or transfer of property. To ensure this notice is given, the Air Force prepares an Environmental Baseline Survey (BBS). Review of the BGP, IRP documents, and other information is required to complete the EBS. With the completion of the EBS, the property is categorized and thus determines whether the transaction may proceed and what type of restrictions may need to be imposed.

**Response:** The first paragraph on page 30 (20 is assumed to be a typo) has been deleted. The suggested text discussing institutional controls has been incorporated.

11. Sec. II.L., Institutional Controls (for the WCA), Page 34. It was EPA's belief the Air Force intended to modify the institutional controls discussion from the Action Memorandum to be consistent with using only the Base General Plan (BGP) as the administrative means for enacting the controls rather than an order requiring landfill restrictions. Such modifications were identified in the proposed plan. The rationale presented was that BGP had the force of an order anyway and the plan modifications were a different administrative process than the "order". Assuming this is correct, the appropriate change would be to delete the first bulletin, keep the rest, and just refer the reader to the institutional controls discussion from the above comment.

**Response:** The bulletin has been deleted and a reference to Section I has been added.

# RESPONSE TO EPA AND WDEQ COMMENTS ON THE DRAFT FINAL AND FINAL ZONE B ROD

## Operable Unit 8, Landfill 5 F. E. Warren Air Force Base 05 July 2001

Most of these comments pertain to follow-up on comments offered on the draft version of this ROD. Because the revisions indicate good faith in addressing EPA comments, EPA is offering suggestions for modifications rather than identifying or initiating a dispute. These mainly pertain to internal consistency and clarity. Some comments are mainly editorial and are offered to improve clarity or readability.

Comments are keyed to the document by Page, Section (Sec.), Column (Col), paragraph, sentence, figure, table, or line as indicated. The general outline structure of the ROD was followed to identify specific comments.

### General Comment

1. There is an apparent inconsistency between the description of institutional controls in the Declaration and Decision Summary. The discussion must (1) clearly identify the mechanism by which institutional controls will be enacted. This can be through the BGP or the Environmental Restoration Land Use Control Plan (ERLUCP), if the ERLUCP is identified as a component of the BGP and is thus similarly enforceable. (2) Describe performance standards for the controls (this is mainly done, which is the prevent access and exposure, etc); and (3) Better define authorized vs. unauthorized (i. e., clarify that access/ activities are generally prohibited except those which are:

(3.1) consistent with the monitoring, operation, and maintenance of the remedy or facilities associated with the remedy ; or

(3.2) approved construction or digging through the Environmental Flight (i.e. John's group) which may require the use of PPE or other conditions placed on activities; or

(3.3) otherwise accepted in consultation with EPA and WDEQ.

The draft language proposed (See Comment 10) also refer to the Air Force in general for access or ground water use, but identifies the base RPM or Environmental Flight as the "approving" authority. This needs to be clarified by the Air Force, since the administrative structures maybe subject to change (e.g., reorganization).

### Specific Comments

2. Sec. I. D., Description of the Selected Remedy, Page 1. Delete the second sentence. It is redundant with the last three sentences.

**Response:** The referenced sentence has been deleted.

3. Sec. I. D., Description of the Selected Remedy, Page 2. The fifth main bulletin discussing institutional controls needs to be rephrased, because the intent of the controls is not solely preventing exposure to contaminated ground water. They are intended to prevent exposure to contaminants in the WCA and to protect facilities which need to be maintained for the remedy to remain effective. Suggested rephrasing is to the effect of "*Institutional controls to prevent exposure to contaminants and assure effectiveness of the remedy, including:*"

**Response:** The referenced sentence has been rephrased as suggested.

The last bulletin will need to identify the actual plan or document by which the institutional controls will be enacted. If this is the Base General Plan (BGP), then

the existing phrasing is accurate. If it will be another plan which appends the BGP (such as Composite Constraints and Controls Plan or Environmental Restoration Land Use Control Plan), this will need to be identified.

The bulletin discussing the annual review of the Base General Plan (BGP) should be a sub-bulletin under the institutional controls.

**Response:** The last bulletin now includes the following text, "Placement of restrictive notices in the Base General Plan (BGP), and in particular the Composite Constraints and Opportunities Plan (CCOP, a component of the BGP) to prevent. . .".

4. Sec. II. D., Page 7, Scope and Role of Operable Unit. In the 4<sup>th</sup> sentence, "the third ROD" should be changed to "the fourth ROD" to be consistent with subsequent discussion. EPA acknowledges "third" was used consistently with EPA's comment on the draft document, but EPA mis-counted.

**Response:** The "third" ROD has been changed to the "fourth".

5. Sec. II. D. (Scope and Role...), last paragraph on Page 8, 3<sup>rd</sup> sentence. Add "(USAF, 2000c)" after "the Action Memorandum" to provide the reader an appropriate reference.

**Response:** The reference has been added.

6. Sec. II. E., Site Characteristics, Groundwater Modeling, Page 13. The statement "The LF5c unit does not exist." does not fit with the discussion of ground water modeling. It belongs in the site overview or can simply be deleted from this location. The next paragraph seems redundant with the first assumption for the model. This paragraph can be deleted without loss of meaning to the discussion or the document.

The last paragraph appears to be intended to provide the reader a resource for finding the information upon which the observation of attenuation being consistent with empirical data is based. There needs to be a statement to that effect.

**Response:** The referenced sentence and paragraph have been deleted. The last paragraph has been modified and appended to the second previous paragraph.

7. Sec. II.L., Summary of the Rationale for the Selected Remedy, Page 28. The two paragraphs following the bulletins appear to be remnants from the earlier structure. They discuss institutional controls, which are not part of the "rationale". Elements of this discussion (appropriately modified to identify the actual document/mechanism which will be used) belongs in a section which discusses institutional controls for the remedy.

**Response:** The two referenced paragraphs have been moved and incorporated into Section I which describes the alternatives, including institutional controls.

8. Sec. II. L., Description of the Selected Remedy (Pages 28 and 29). This discusses most of the major components of the remedy, but not institutional controls. The discussion currently under "Performance Monitoring Goals" belongs in a separate subsection entitled "Institutional Controls".

**Response:** The discussion addressing institutional controls under "Performance Monitoring Goals" has been moved to Section I, Description of Alternatives. An abbreviated description and separate subsection entitled "Institutional Controls" has been included in the subsection "Description of the Selected Remedy" prior to the subsection "Performance Monitoring". Additionally, the discussion of institutional controls pertaining to the WCA has been moved to reflect a similar organizational format.

9. Sec. II. L., Performance Monitoring Goals, Page 29. Add a bulletin to address the administrative monitoring of the institutional controls, perhaps to the effect of "Assessment of the effectiveness of the institutional controls in preventing exposures and assure maintenance of facilities which need to be maintained to assure effectiveness of the remedy."

**Response:** The suggested bulletin with minor modification has been added to address the administrative monitoring of the institutional controls.

10. Sec. II. L., Performance Monitoring Goals, Pages 30 and 31. Most of this discussion is what belongs in a section discussing institutional controls (See Comment 8 above). The first paragraph on Page 30 which discusses the WCA is probably not needed since the controls for the WCA are discussed later. The remaining discussion needs to be rephrased into plainer English. Move the specific citations of the Air Force Instructions (APIs) to the section for References. Draft suggested language is as follows:

*The Air Force comprehensive planning process and BGP are similar to civilian local land use and planning processes, such as zoning, easements, rights-of-way, use of natural resources, and permitting for construction activities, such as digging. They have the effect of a direct order of the Secretary of the Air Force through a set of Air Force Instructions (APIs) and compliance is mandatory. The Installation Commander is responsible to ensure the comprehensive planning documents are developed, maintained and implemented. The Installation Commander must approve the BGP. A requirement of the APIs is to identify IRP sites (sites of known or potential contamination), where notes regarding specific institutional controls are placed as needed. These controls may be simply informational or serve as legal/management controls to restrict access, activities, and use of natural resources.*

*The institutional controls for the IRP sites at F. E. Warren Air Force Base will be enacted by modifying the Base General Plan, either directly or through an addendum to the BGP (such as an Environmental Restoration Land Use Control Plan). Specific language will prohibit unauthorized access to the facilities for the remedy at the IRP site or use of natural resources. Known or possible areas of contamination will be placed on the Land Use Map. The BGP and Land Use Map will be updated as necessary, but no less than annually, to incorporate institutional controls and monitor their implementation and effectiveness. These controls cannot be removed without prior approval by the Air Force (the Air Force Remedial Project Manager or Chief of Compliance) with acceptance of the changes by EPA and WDEQ.*

*Normal monitoring and operation and maintenance activities or other environmental activities conducted under plans accepted by EPA and WDEQ will be authorized activities. The BGP modifications will otherwise prohibit the use of ground water. Because municipal supplies are readily available, there are no current plans for use of ground water at FEW.*

*Modifications to the BGP will also prohibit access to facilities and construction or earth disturbances in certain areas (e. g., which would disturb the engineered cover on the WCA). In some cases, such as landfills which will remain in place in perpetuity, notices of the restrictions will be filed in the real property records in Laramie county. Fencing will be used as controls to prevent unauthorized access and potential exposure. In addition to minimizing potential exposures to humans, these restrictions will protect the facilities which are part of the remedy. Necessary activities can be conducted with approval of the Air Force, generally in consultation with EPA and WDEQ. These may be addressed in the BGP or through the permitting process at FEW, which is required for digging and earth work. Some activities may be approved but require air monitoring or the use of personal*

protective equipment for workers or other constraints to assure worker health and safety requirements are met.

Advisory or informational controls will be used in addition to the legal/management controls. These include signs to identify access restrictions and warning of potential hazards in source areas. Also, community information and educational programs will enhance community understanding and awareness of the potential hazards.

Although considered unlikely, institutional controls would need to be revised in the event of property transfer. The installation was created by an act of Congress, and thus no conventional property deed exists. In the event of transfer, a deed with restrictive covenants may need to be created. CERCLA Section 120( h) requires the Air Force to provide notice of hazardous substance releases and assurances that all remedial action has taken place or will be completed in any deed or transfer of property. To ensure this notice is given, the Air Force prepares an Environmental Baseline Survey (EBS). Review of the BGP, IRP documents, and other information is required to complete the EBS. With the completion of the EBS, the property is categorized and thus determines whether the transaction may proceed and what type of restrictions may need to be imposed.

**Response:** The first paragraph on page 30 (20 is assumed to be a typo) has been deleted. The suggested text discussing institutional controls has been incorporated.

11. Sec. II. L., Institutional Controls (for the WCA), Page 34. It was EPA's belief the Air Force intended to modify the institutional controls discussion from the Action Memorandum to be consistent with using only the Base General Plan (BGP) as the administrative means for enacting the controls rather than an order requiring landfill restrictions. Such modifications were identified in the proposed plan. The rationale presented was that BGP had the force of an order anyway and the plan modifications were a different administrative process than the "order". Assuming this is correct, the appropriate change would be to delete the first bulletin, keep the rest, and just refer the reader to the institutional controls discussion from the above comment.

**Response:** The bulletin has been deleted and a reference to Section I has been added.

## RESPONSE TO EPA COMMENTS

### Draft Final Record of Decision for Zone B Operable Unit 8, Landfill 5 F. E. Warren Air Force Base Cheyenne, Wyoming 03 May 2001

EPA Comments are structured as General Comments and Specific Comments. General Comments may pertain to the document as a whole or summarize issues. Specific Comments are keyed to the document by Page, Section (Sec.), paragraph, sentence, figure, table, or line as indicated.

#### Declaration

1. Sec. I.D., Description of the Selected Remedy. Page 2. In the bulletin discussing institutional controls, add a brief phrase about 'preventing unauthorized access to the WCA'. Add a bulletin stating the Base General Plan will be reviewed annually and modified as needed to assure the appropriate controls are maintained.

#### Response:

*Text stating "prevent unauthorized access to the WCA " has been added to the bulletin on institutional controls. A bulletin has been added stating "Annual review of the Base General Plan and modification as needed to assure the appropriate controls are maintained."*

#### Decision Summary

2. Sec. II. A., 2nd and 4th paragraphs. In general re- organized well. However, there are still some references to the FFA in these paragraphs, which appear before any explanation of what the FFA is. Suggest mainly deleting the references to the FFA: 2 nd paragraph, second sentence, end with "investigation" and 4 th paragraph, second sentence, end with "concurrence".

#### Response:

The suggested deletions have been made.

3. Sec. II. C., Highlights of Community Participation. Identify the specific fact sheet(s) which pertained to the Zone B remedy, including discussions in *EnviroNews* (if any) and those which were mailed. Specify the mailing date. Identify that the RAB members were briefed periodically on Zone B (OUS) and were specifically consulted on the preferred alternative in the 14 November 2000 meeting.

#### Response:

*The second paragraph has been revised to state: "The USAF prepared and distributed one fact sheet describing the preferred alternative for Zone B to all persons or groups identified on the CRP mailing list. The fact sheet was mailed on 13 December 2000. " Text has been added to the fourth paragraph, next to last sentence, where RAB members were briefed, "and were specifically consulted on the preferred alternative in the 14 November RAB meeting.*

4. Sec. II. E. Site Characteristics. Provide a brief description of the hydrogeology to provide a basis for site conceptual modeling and hydrological modeling.

**Response:**

Text has been revised to:

The conceptual site model (CSM) for Zone B identified LFSb waste as the primary source of TCE in groundwater. This landfill waste was situated within geologic materials primarily consisting of interbedded clays, silts, sandy silts, and silty sands. The principal contaminant release mechanism is assumed to have been leaching of buried waste within LFSb and subsequent infiltration to groundwater. Groundwater in the area of LFSb is approximately 10 to 15 feet below the ground surface and aquifer materials consist of interbedded clays, silts, sandy silts, and silty sands. LFSb is no longer a source of current or future contamination to the surrounding environment due to the excavation and removal of the landfill in 2000 and expected clean closure.

Migration of contaminated groundwater from LFSb is controlled by local hydraulic gradients that trend in a northeasterly direction toward Unnamed Tributary. Typical horizontal gradients are approximately 0.01 feet/foot. Using this data and an average hydraulic conductivity value of 7.4 feet/day, a typical groundwater velocity of 0.37 feet/day (135 feet/year) was calculated. As contaminated water migrates downgradient of LFSb, empirical data and model simulations indicate that contaminant concentrations attenuate due to natural processes of volatilization, dilution, and adsorption.

Figures 3 and 4 depict the human health and ecological CSMs for Zone B. These models illustrate the primary contamination source (landfill waste), release mechanisms, exposure pathways, migration routes, and potential human and ecological receptors. These CSMs form the basis for the risk assessment conducted for the site (see Section G below).

5. Sec. II. E. Sampling Results, Page 10. Additional information is needed to appropriately describe the modeling and the major assumptions on which the model is based. Describe the manner in which the source was addressed in the model. Clarify whether a historical mass release of contaminant of a certain date was input into the model or whether current concentrations were used and the model "run" forward from the present. Briefly describe the calibration of the model, indicating whether the model was calibrated with respect to hydrological or contaminant parameters. Indicate the "degree" of calibration (i. e., the level to which the calibrated model corresponded to empirically observed data.

Summarize the empirical information demonstrating attenuation. The statement "Contaminant fate and transport modeling indicates that the TCE (trichloroethene) is mobile and TCE concentrations are not increasing within the plume and, in fact, are decreasing through a process called natural attenuation" introduces the discussion which needs to be added. Items to include may be decreases in concentrations with distance from the source, decreases at locations in time, or the stability of the plume.

**Response:**

The following text has been substituted for the modeling portion of the text in the subsection - Sampling Results: Nature and Extent of Contamination.

**Groundwater Modeling**

Groundwater flow and transport modeling was conducted to improve the understanding of the site hydrogeologic and groundwater contaminant conditions and to simulate

various remedial alternatives. Detailed description of the model's development can be found in Appendix A of the Zone B FS (USAF 2000b).

A steady state groundwater flow model for Zone B was developed using MODFLOW, the USGS finite difference code. This model covers an area of about 3000 feet by 2000 feet, and is orientated with the primary groundwater flow direction. The model is comprised of two layers based on the assumption that no distinguishable hydrostratigraphy is found at the site. The groundwater potentiometric surface was interpreted from the measured hydraulic heads in September 1999 (Figure 5). These data were used as the target for model calibration, assuming that minor seasonal groundwater fluctuation is negligible in assessing contaminant migration. The bottom of model Layer 1 is assumed to be 40 feet below the interpreted potentiometric surface and the bottom of model Layer 2 is assumed to be 40 feet below the bottom of Layer 1. Boundary conditions for all sides of the model domain were assumed to be prescribed head boundary conditions with specified values as same as the interpreted potentiometric surface at the boundaries.

The flow model was calibrated to the interpreted potentiometric surface using the depth-weighted average hydraulic conductivity that ranges from 3 to 30 feet/day. An automated groundwater model calibration package MOD AC (Guo and Zhang 2000) was used. The final areal groundwater recharge rate was calibrated as 1.0 inches/year in the area of recharge (majority of area) and -0.5 inches/year along the Unnamed Tributary to reflect evapotranspiration along the creek. The calibrated potentiometric surface generally matches the interpreted one, which indicates that the simulated hydraulic heads match the measured hydraulic heads.

The three-dimensional groundwater solute transport code MTDMS (Zheng and Wang 1998) in conjunction with MODPATH, a particle tracking code, was used to simulate the TCE plume migration in groundwater. Various conditions were modeled to evaluate the potential effect of remedial alternatives. Assumptions applied in the solute transport model include:

- No source was simulated, reflecting the condition that LFSb has been excavated.
- The interpreted horizontal TCE plume based on September 1999 measurements was assumed to be the initial concentration distribution in the upper 40 feet of the saturated zone (Layer 1).
- Longitudinal and transverse dispersivity values are assumed to be 2.0 feet and 0.2 feet, respectively.
- No biodegradation was simulated.
- The retardation factor was calculated as 3.1 based on assumed parameters for soil density, effective porosity, fraction organic carbon, and  $K_{oc}$ .

No calibration was performed for the transport model. The transport model simulates the future plume migration under either natural conditions or active remedial conditions. The initial concentration distribution is assumed to be the same as the 1999 conditions without the presence of the contaminant source. The natural attenuation simulation indicates the TCE plume is mobile, and the TCE concentrations will be continuously decreasing over time within the moving plume. This is consistent with empirical data in that the observed high concentrations in the center of the plume have continuously decreased between 1994 and 2000.

6. Sec. II. G. Summary of Site Risks. Briefly address the source within the exposure assessment (i. e., LFSb has been excavated to presumed clean closure) and the resultant role in assessing risk. The added discussion of uncertainty in assessing the risks needs to elaborate on the assumptions contributing to uncertainty and the role of the assumptions (potential overestimation or underestimation of risk).

**Response:**

Text has been added:

*LFSb is considered the primary source of contaminants in Zone B. Historically, contaminants may have been transported from LFSb through percolation of leachate or liquid waste to vadose zone soil and groundwater, or through windblown transport of contaminated dust to surrounding soil. Currently, waste from LFSb has been removed and relocated to the Waste Co- location Area (formerly LFSa). Because wastes were excavated, LFSb is expected to achieve "clean closure " and is no longer a source of Zone B contaminants.*

*The major sources of uncertainties associated with the methodologies and assumptions in the Zone B risk are summarized as follows:*

- The samples may not have adequately represented media at the site. Because samples were taken where contamination was suspected instead of randomly, exposure point concentrations and resultant hazard/ risk estimates were most likely overestimated.*
- The minimum detection limit for a few analytes that were eliminated as COPCs (because they were not detected) exceeded toxicity screening values used to identify COPCs. If these analytes were in fact present at the site, the estimated risks may have been underestimated.*
- Utility worker exposure to groundwater was not quantitatively evaluated. The estimated risk to utility workers may have been underestimated, however, exposure and risk are likely low.*
- Because concentrations of chemicals in site media may decrease over time as chemicals migrate and/or degrade, risk estimates for current scenarios may overestimate or underestimate future risks.*
- Exposure point concentrations used in the risk assessment were the 95% UCL or maximum value (whichever was smaller). Using these concentrations probably overestimates risk.*
- Standard assumptions regarding body weight, exposure duration, life expectancy and population characteristics may not be representative of actual Zone B exposure situations. Most of these exposure parameter values are reasonably high-end estimates. Where there was a high uncertainty regarding exposure parameter values, conservative (health protective) values were used. This most probably resulted in an overestimation of risk.*
- Proxy toxicity data were used whenever possible for chemicals that lacked toxicity data to screen for COPCs. If proxy data underestimated a chemical's toxicity, risk may have been underestimated. However, it is more likely that the proxy data overestimated a chemical's toxicity and risk was overestimated.*

- Trichloroethene toxicity values used in the risk assessment were unverified provisional values, which probably overestimated risk.
- Sources of uncertainty in toxicity data, (e. g. extrapolation of animal data to humans, use of high dose response to predict low dose response, use of data from short term studies to predict long term effects, and employing toxicity values for one exposure route to another exposure route) may result in overestimation or underestimation of risk.
- Possible synergistic or antagonistic effects of exposure to multiple chemicals may result in underestimation or overestimation of risk.

7. Sec. II.L. Pages 25 and 26. Add a brief summary of the institutional controls which will apply to the pumping, treatment, and monitoring systems. To maintain a parallel structure to the similar discussion for the WCA, this should follow "Performance Monitoring Goals".

**Response :**

Response: A subsection titled "Institutional Controls" has been added. The following text has been added: "APIs are recognized as the most effective means of implementing and enforcing institutional controls. According to API 33- 360, Volume 1, Publications Management Program, 31 July 1998, paragraph 2.2.4, "Instructions are order of the Secretary of the Air Force and are approved in the Secretariat of the Air Staff..." In addition, paragraph 2.2.4 provides that "Instructions must contain the banner statement "COMPLIANCE WITH THIS PUBLICATION IS MANDATORY" across the top of the page. Compliance with API's is mandatory at all Air Force levels - MAJCOM [( Major Command)], FOA [(Field Operating Agency)], DRU [(Direct Reporting Unit)], Wing, and Base. (Emphasis in original). AFI32- 7062, Air Force Comprehensive Planning, 01 October 1997, Paragraph 1.3.6 places responsibility on the Installation Commander to ensure the comprehensive plan documents, including the General Plan, "are developed, maintained and implemented..." and the Installation Commander must approve the General Plan. Paragraph 2.2 provides that the comprehensive planning process, which includes the General Plan, " consolidates plans and programs related to the management and development of Air Force lands, facilities, and resources into a document that is used to guide future growth and development. " Therefore, the Air Force comprehensive planning process and General Plan are similar to civilian local government land use planning processes.

Paragraph 2.3.1 provides that a General Plan is required for all major installations, which includes FEW. Paragraph 2.6 provides that the General Plan must be reviewed at least annually "to ensure it reflects current information regarding the installation's conditions and programs. " Administrative monitoring of the General Plan will take place on an annual basis to ensure that the language concerning the IRP is incorporated.

A component of the General Plan is the Composite Constraints and Opportunities Plan, for which AFI 32-7062, paragraph A4.1 provides, "Through this integration of information, critical areas having limited or specialized development potential are highlighted and factored into the planning process. " Therefore, the Composite Constraints and Opportunities Plan would be an ideal place in which to provide institutional controls from the IRP. In addition, AFI 32-7062, Attachment 6, Table A6.1 requires that the General Plan must include a map regarding IRP sites, which could also include notes regarding institutional controls. Therefore, institutional controls provided in the General Plan are designed to be both informational and control surface access.

Regarding property transfers, CERCLA Section 120(h) requires the Air Force to provide notice of hazardous substance releases and assurances that all remedial action has taken place or will be completed in any deed for transfer of property. The Air Force ensures that this notice is given by preparation of an Environmental Baseline Survey (EBS). In completing the EBS, AFI 32-7066, paragraph 2.1.1.1 requires the Air Force to review the base comprehensive plans and IRP documents. Based on these and other reviews, whether hazardous substances were released in the area, and whether remedial action has been completed, AFI 32-7066 provides several different categories of conclusions in the EBS. These conclusions, in turn, determine whether the transaction may proceed and what type of restrictions may need to be imposed.

The General Plan can also prevent unauthorized use of or exposure to contaminated groundwater in that only the base RPM can authorize use of the groundwater. At this time, municipal water supplies are readily available and there are no current plans to utilize groundwater. Any deviation from this current plan would require authorization from the base RPM. Appropriate institutional controls relevant to Zone B groundwater contamination include legal/management controls and community information programs. Legal/management controls include notices in the General Plan regarding development and use restrictions for the area. The notice would be placed on the Land Use Map and in the Composite Constraints and Opportunities Plan.

Revisions to the General Plan that relate to Zone B will be incorporated after the Zone B ROD is final. At that time, a draft of the revisions will be provided to the RPMs for review and comment. After addressing comments, the revised General Plan will be presented for approval to the Installation Commander during the annual review.

FEW would update the Base General Plan to incorporate institutional controls and track their implementation. The notice in the General Plan will include a provision that the notice should not be removed without prior approval by the Air Force RPM or Chief of Compliance. EPA and WDEQ would need to review and accept the changes to the plan.

Additional controls could be maintained through construction work requests and digging permits. These processes could require the review and approval by the Environmental Flight.

Community information and educational programs would be developed to enhance community understanding and awareness of the potential hazards posed by the source. The responsibilities of communities and individuals in the adherence to and maintenance of fencing or postings would be thoroughly discussed."

8. Sec. II. M. Page 31. In the last paragraph, the reference to where the WCA ARARs are tabulated needs to be corrected. The paragraph states Attachment A8- 2 of this ROD, but it is in Attachment A8- 4 in which they are found.

**Response:**

Text referencing the WCA ARARs has been corrected to: "Attachment A8-4."

**Responsiveness Summary**

9. Sec. III. Responsiveness Summary. There is no "Selected Remedy" until the ROD is written. It is a "preferred alternative" until that time. This can be addressed with some simple editorial changes. In the first sentence, replace "... the Selected Remedy at Zone B had been selected ..." with a phrase to the effect of "... Zone B

had been identified...". At the end of the second sentence, add "as the preferred alternative". EPA acknowledges this was not a comment offered on the draft. However, the change is relatively minor.

**Response:**

Text has been revised to:

In the first sentence, "... the Selected Remedy at Zone B had been selected..." has been replaced with the phrase "... Zone B had been identified... ". At the end of the second sentence, "as the preferred alternative " has been added.

10. Table A8-1. Sheet 1 of 8. Safe Drinking Water Act. The comments section in both the primary drinking water regulations and MCLs discussions refer to "this FS". Delete these sentences from each, to prevent confusion. Edit all tables to be consistent with only this ROD. EPA acknowledges this was not a comment offered on the draft. However, the change is relatively minor.

**Response:**

Sentences beginning with "This FS" have been deleted from Table A8-1.

## RESPONSE TO WDEQ COMMENTS

### Draft Final Record of Decision for Zone B Operable Unit 8, Landfill 5 F. E. Warren Air Force Base Cheyenne, Wyoming 03 May 2001

#### General Comments

1. Please provide a table of contents, list of figures, list of tables, list of appendices, and list of acronyms used for this report.

#### Response:

A table of contents, list of figures, list of tables, list of appendices, and list of acronyms has been included.

2. The document should discuss the northern TCE plume in more detail. The document mentions that a plume exists to the north associated with an "off-base" source, but fails to definitively support this statement. The WDEQ has suggested referencing specific documents (or investigation activities) that indicate that this plume is from an off base source, and providing a brief summary of the conclusions of those documents (investigations).

#### Response:

Text from the Zone B FS (USAF 2000b) that discusses the northern plume in more detail has been added. This text replaces the Draft Final Zone B ROD discussion of the northern plume found in Section E, subsection: Sampling Results: Nature and Extent of Contamination. The new text states:

*As discussed in the RI Report (USAF 2000a), a second TCE plume was identified about 200 feet north of the LFSb TCE plume. This plume is assumed to have a separate, off-site source as evidenced by the TCE concentrations located hydraulically upgradient of LFSb and at the edge of the base property (e. g., wells MW-020 and LF5-102). The highest reported TCE concentration in this plume was 10.4 ug/L detected in well LF5-103D. The plume extends for a length of approximately 1,400 feet and has an average width of 150 feet.*

*Based on contaminant distribution and direction of groundwater flow, the contaminant source is understood to be hydraulically upgradient of LFSb and located off base. Because of the off-base origin of the contaminant source, this plume is not being addressed for cleanup in this Zone B FS.*

#### Specific Comments

1. Section C., page 6. The Section states that fact sheets were issued periodically. Please explain the period between issuing fact sheets. For example, is there a regularly scheduled fact sheet issuance or is issuance frequency based on substantial amounts of new information becoming available? Also, please add a list of fact sheets relevant to Zone B and to this remedy that have been issued to date.

#### Response:

See response to EPA Comment No. 3.

2. Section E, Subsection: Sampling Results: Nature and Extent of Contamination, page 9, second paragraph of this subsection, first sentence. Change "In groundwater, only TCE" to "In groundwater, TCE". The word "only" does not add meaning to the sentence and suggests a minimization of the contamination.

**Response:**

The word 'only ' has been deleted.

3. Same paragraph, as interpretations are offered for possible laboratory and field contamination and off base sources, an interpretation of LFSb as the likely source of TCE in the groundwater also ought to be described.

**Response:**

Text has been added to Section E, subsection: Conceptual Site Model that identifies "LFSb waste as the primary source of TCE in groundwater. "

4. Section E, Subsection: Sampling Results: Nature and Extent of Contamination, page 9, third paragraph of this subsection. Change third sentence to: The TCE detections north and west of LFSb are interpreted to be unrelated to the source of the larger, higher-concentration TCE plume. Also add something to the effect, that this smaller, lower-concentration TCE plume could be a 'slug' of TCE from the same source as the larger plume, or could be from similar on-base sources that have now dissipated to the point where there is no longer any evidence other than the remaining lower-concentration plume. Although known groundwater flow and hydraulic gradient suggests a separate source (though not necessarily off-base) these parameters can change through time or in response to events such as heavy rains, wet or dry years, or changes in topography (erosional or anthropogenic).

**Response:**

The third paragraph has been rewritten to provide more detail about the northern plume (see WDEQ General Comments No. 2). Neither contaminant distribution nor hydrogeologic data indicate TCE in the northern plume as being from "the same source" as the TCE plume originating from LFSb.

5. Section I. Subsection: Description of Remedy Components. Sub-subsection Alternative 2. Institutional Controls, page 18, first paragraph - Change second bulletin "Review and approval of construction work requests" to "Review and approval or denial of construction work requests". This bulletin needs re- wording to make its intent clear, additional detail as to how and by whom these controls will be maintained and managed is needed. For example, bulletin one states that the Base General plan will be updated to prohibit unauthorized access, etc. What exactly will prevent unauthorized access, fencing? And, who will enforce this, security staff? Some additional detail is provided on page 29 in the subsection Institutional Controls regarding the WCA so these issues could be addressed there.

**Response:**

The second bullet has been changed to: "Renew and approval or denial of construction work requests. " Also see response to EPA Comment No. 7.

6. Section L., page 27. between the sub-sections Performance Monitoring Plan Review and Summary of Estimated Remedy Costs add a sub-section describing Institutional Controls related to Alternative 5. Groundwater Extraction and Treatment, similar to the sub-section on page 29 describing Institutional Controls related to Alternative 2. Also please address the issues noted in the previous comment regarding the details of the Institutional Controls.

**Response:**

See response to EPA Comment No. 7, a subsection titled "Institutional Controls " has been added.

**Figures**

7. Figure 5, Aerial Extent of TCE Plume in Zone B and Figure 6, Vertical Extent of LFSb TCE Plume, show TCE concentrations, for example, of (0.865). The Explanations of these figures state that this value is in ug/ 1. Is a variation of 1/ 1,000 of a ug/ 1 an accurate measurement? If so, is this number of decimal places useful on a figure? If it is not accurate it should be corrected. If it is accurate it should be rounded off to one decimal place or less.

**Response:**

The resolution of 1/1000 of a ug/L is a measurement reported by the laboratory. The figure will remain as is for consistency with the reported data and the RI and FS documents (USAF 2000a, 2000b).

8. Figure 5, Aerial Extent of TCE Plume in Zone B Explanation has dates of 1999, 2000 in parentheses following text in two places. This needs explanation as to whether results from two sampling events were combined to produce these figures or what, exactly, is meant by the two dates.

**Response:**

A third sampling event in 2000 was added to address several wells that were not sampled in 1999 (e. g., LF5-2 cluster). These data were added to the 1999 data set.

9. Please add a summary table showing dates of sampling events, monitoring wells sampled in each event, and results of analyses for TCE to support the information presented in the figures referenced above.

**Response:**

A summary table with dates of sampling events monitoring wells sampled and results of analyses for TCE can be found in the RI Report (USAF 2000a).

**Tables**

10. Table A8-1, Sheet 1, WYOMING ENVIRONMENTAL QUALITY ACT citation should be changed from "W. S. 35-11-101 to 35-11-1428" to "W. S. 35-11-101 to 35-11-1803".

**Response:**

The citation has been changed to "W. S. 35-11-101 to 35-11-1803. "

## ERRATA SHEET

The following changes were made to the Draft Final Zone B ROD to be consistent with comments made on the Draft Zone A ROD.

### 1. Section II. A., Site Name, Location and Description

A summary of the land use description in Section II. P., Current and Future Land and Water Uses has been added.

### 2. Section II. D., Scope and Role of Operable Unit.

Text has been added to the first paragraph of II. D. to discuss the planned sequence of site-wide activities and how OUS fits into the sequence. Previous final RODs included OUL, OU4, and OUS. The investigation and cleanup process for the remaining OUs at FEW are anticipated to continue for the next several years with the last OU ROD scheduled for 2009. Text has been added after the second full paragraph: "There have been three previously completed RODs for final remedies at FEW. The OU4 ROD was signed on 30 December 1992 and addressed the contamination associated with an acid dry well at the old transportation complex. Based on previously completed contaminated soil removal, the baseline risk assessment indicated no significant risk to human health and the environment. Therefore, no further action was required at this site.

OUS addressed the Fire Protection Training Area #2 (FPTA2) soils. The ROD for this OU was signed on 4 November 1994 and also indicated no further action required based on the risk assessment findings of no significant risk to human health and the environment. As part of this decision, the groundwater beneath FPTA2 was made part of OU2 basewide groundwater.

The OUL ROD was signed on 9 August 1995 and addressed the contaminated soils at spill sites 1 through 7. The risk assessment conducted for this OU indicated that there was no significant risk to human health and the environment; therefore, the ROD indicated that no further action was required for the soils at these sites. However, the groundwater beneath these sites was not included and it was also made part of OU2, which is presently in the investigation phase of the cleanup process.

The remaining OUs will be investigated and RODs completed in the following general order: OU8-2001, OUL1-2001, OU3-2001, OU6-2002, OU9-2003, OUL2-2003, OU 10-2004, OUL3-2004, OU2-2005, and OU7-2009.

Presently, the OUS design investigation activities are scheduled for Fall 2001, design activities are scheduled for completion in Spring 2002 with implementation of the remedy in late 2002 and early 2003. This action, together with the early responses previously completed, will be the final action for Zone B and will result in permanent reduction of toxicity, mobility, and volume of the contamination at the site."

### 3. Section II. E., Site Characteristics

Additional text has been provided discussing the source and conceptual site model. Refer to the response to EPA comment No. 4.

### 4. Section II.L, Subsection - Common Elements and Distinguishing Features of Each Alternative Language addressing the "5-year Review" has been modified to:

"Because these alternatives will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after

initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment. "

5. Section H. M., 5-year Review Requirement. Text has been replaced with model language provided by EPA:

"Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment. "